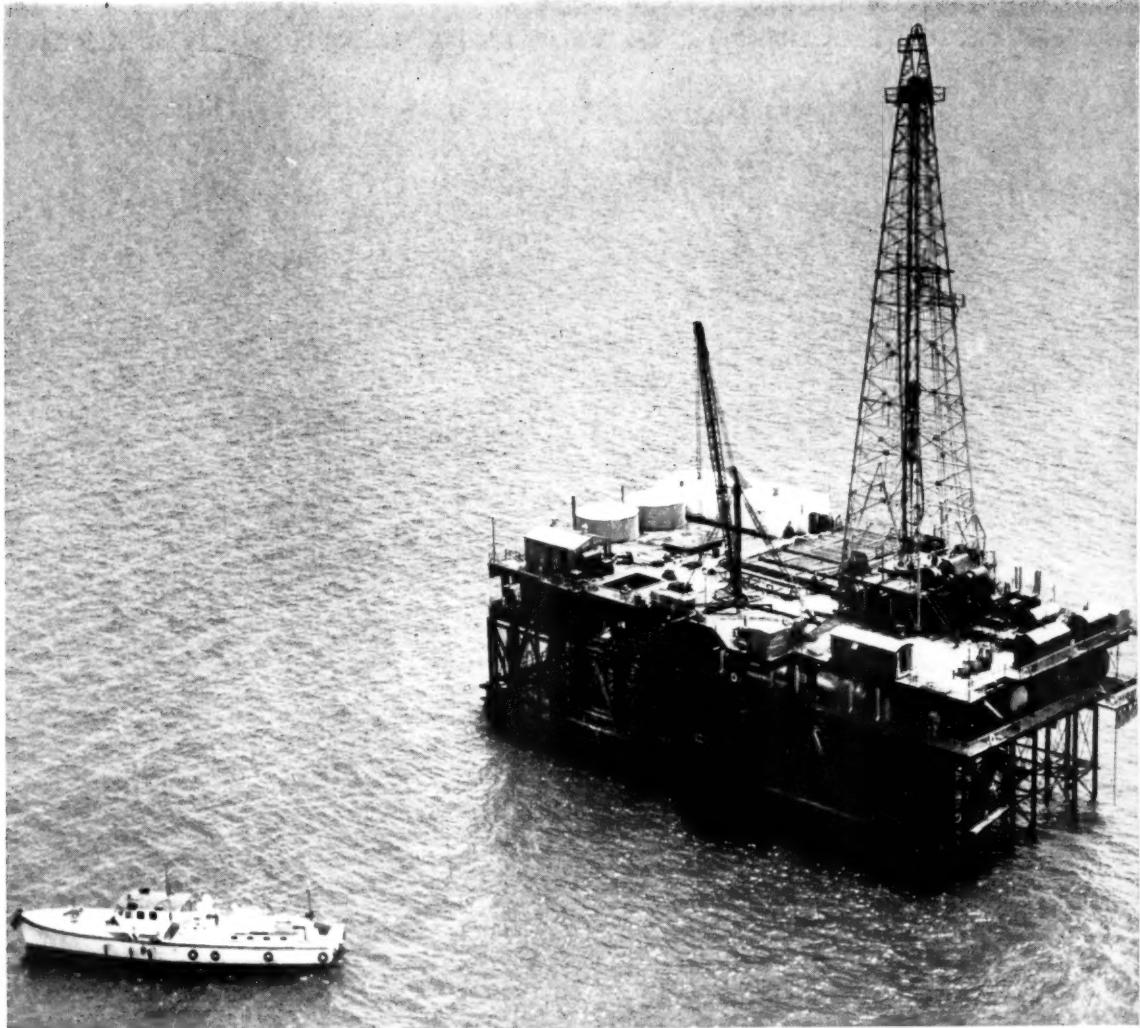


*Technology*

# Midwest Engineer

SERVING THE ENGINEERING PROFESSION



Vol. 2

THE ENGINEER IN THE OIL INDUSTRY  
FURNACES FOR BY-PRODUCT FUELS  
WSE CALENDAR—PAGE 2

SEPTEMBER, 1949

No. 1

TR v.2 Sept. 1949 - May 1950

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MIDWEST ENGINEER  
Published Monthly  
except June, July, August by  
THE WESTERN  
SOCIETY OF ENGINEERS  
at  
2207 Dodge Avenue  
Evanston, Illinois

The Society does not assume responsibility for statements and opinions in articles, papers and discussions appearing herein. All material must be submitted on or before the 10th of the month prior to date of publication.

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Single copy ..... \$ .35  
Annual subscription ..... 3.00  
Foreign postage ..... 1.00  
(Additional, per year)

Entered as second-class matter September 23, 1948 at the post office at Evanston, Illinois under the Act of March 3, 1879.

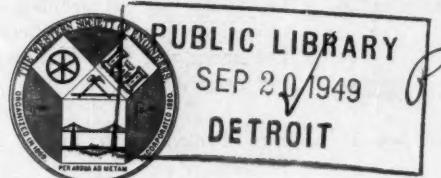
TECHNOLOGY DEPARTMENT

# MIDWEST ENGINEER

A Publication of the

WESTERN SOCIETY OF ENGINEERS

Serving the Engineering Profession



September, 1949

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### COVER CREDIT

Showed on our front cover is a platform for drilling oil, erected in the Gulf of Mexico at a cost of \$1,200,000. Courtesy of Humble Oil and Refining Company.

COMING IN THE OCTOBER ISSUE:

### CIVIC IMPROVEMENTS FOR CINCINNATI

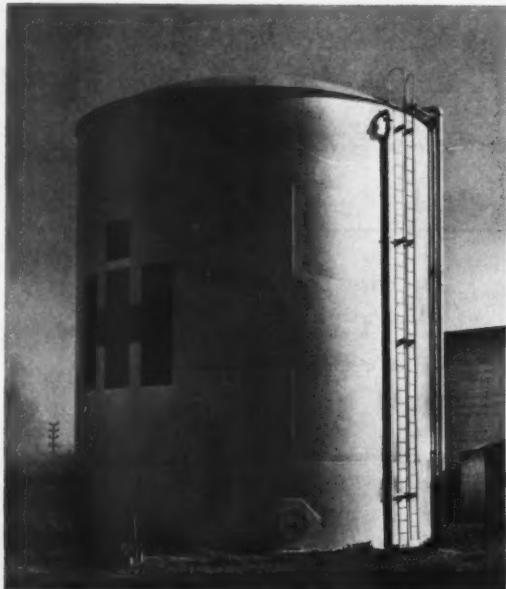
### INDUSTRIAL RESEARCH AND ITS RELATION TO CORPORATION MANAGEMENT

THE TALGO TRAIN

## WSE CALENDAR OF EVENTS

October 10	Bridge & Structural Engineering Section	February 6	Bridge & Structural Engineering Section
October 17	Chemical & Metallurgical Engineering Section	February 13	Chemical & Metallurgical Engineering Section
October 24	<i>Annual Fall Dinner</i>	February 20	Communications Engineering Section
October 31		February 27	<i>Washington Award Dinner</i>
November 7	Communications Engineering Section	March 6	Electrical Engineering Section
November 14	Civic Committee	March 13	Fire Protection & Safety Engineering Section
November 21	Electrical Engineering Section	March 20	<i>Joint Meeting</i> —Bridge & Structural Engineering Section, Transportation Engineering Section
November 28	<i>Joint Meeting</i> —Hydraulic, Sanitary & Municipal Engineering Section, Traffic Engineering & City Planning Engineering Section	March 27	Consulting Engineering Division
December 5	Fire Protection & Safety Engineering Section	April 3	Gas, Fuels & Combustion Engineering Section
December 12	Gas, Fuels & Combustion Engineering Section	April 10	Hydraulic, Sanitary & Municipal Engineering Section
December 19	Hydraulic, Sanitary & Municipal Engineering Section	April 17	Mechanical Engineering Section
January 9	Mechanical Engineering Section	April 24	<i>Joint Meeting</i> —Chemical & Metallurgical Engineering Section, and Gas, Fuels & Combustion Engineering Section
January 16	Traffic Engineering & City Planning Section	May 1	Traffic Engineering & City Planning Section
January 23	<i>Joint Meeting</i> —Communications Engineering Section, Electrical Engineering Section	May 8	Transportation Engineering Section
January 30	Transportation Engineering Section	May 15	Women's Division
		May 22	<i>Joint Meeting</i> —Mechanical Engineering Section, and Fire Protection & Safety Engineering Section
		May 29	<i>Annual June Dinner</i>
		June 5	Junior Division

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Horton flat-bottom steel storage tanks; elevated water tanks; cylindrical, spherical and spheroidal pressure containers—these are a few of the types of welded tanks and steel plate structures we are fabricating and erecting for expanding Midwest industries and cities. The tank shown at the left, for example, is a 200,000-gal. flat-bottom unit—a type of storage tank used in many industries. This structure is 31 ft. 6 in. in diameter and 35 ft. high, and is used to provide water for an automatic sprinkler system.

Welded steel construction has these advantages—(1) dependable tightness—the joints are built tight and stay tight, (2) economical maintenance—regular painting keeps the tanks in good condition, and (3) smooth appearance—butt-welded joints and curved surfaces blend into the most modern plant locations.

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# The Engineer in the Oil Industry

Dr. Gustav Egloff  
Universal Oil Products Company  
Chicago, Illinois

The engineer is a key figure in every phase of the oil industry, from the discovery of oil to the marketing of refined products. Engineering problems of diverse character are encountered in exploring, drilling, producing, transporting, refining and marketing. In an industry growing rapidly in size and complexity, there is increasing need for efficiency in all operations and for the development of new processes.

## Exploration

The scientific exploration for petroleum is a cooperative venture to which engineers as well as geologists, geo-physicists, paleontologists and chemists contribute. At the present time, the latest scientific methods are being used

valuable tool which indicates the character of earth structures, and plots formations. Exploring for petroleum has been conducted in the stifling heat of Arabian deserts, in the numbing cold of the Arctic, and over the waters covering the Continental Shelves.

## Drilling

The original oil wells were drilled by the same percussion methods that were used in drilling water and salt wells. These percussion methods are effective in over half of the wells being drilled. However, when formations are soft or when deep wells are called for, rotary drilling methods are required. Present estimates indicate that from 40 to 45 per cent of oil well drilling projects are using the rotary method, although the percentage varies from time to time.

## CABLE DRILLING

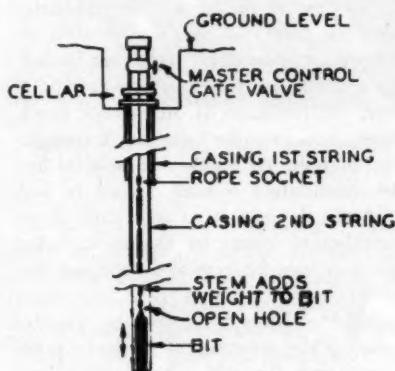


FIG. I

COURTESY AMER. PET. INST.

to locate oil. Vast areas of the earth's surface are being mapped by aerial photography which permits preliminary examination of terrain difficult to traverse on foot, such as mountains, jungles, swamps and deserts. The electronics engineer makes use of radar techniques in surveying. Subsurface mapping is done in part by the gravimeter and the magnetometer transported in airplanes and ships. The seismograph is a

Figure I is a diagrammatic representation of a cable tool rig for percussion drilling. The heavy bit is alternately raised and dropped, and the crushed rock particles are intermittently removed from the hole by a bailer, a column of water being maintained in the drill hole to facilitate the bailing operation. The cable drilling method can only be used to penetrate formations which are hard enough to prevent collapse of the drill hole. Besides this limitation, another is imposed by the change in harmonic frequency of the drilling line as well depth increases. In the early stages of cable drilling there may be 35 strokes per minute, but at 7,000 feet only 15 strokes per minute are possible and drilling is slowed to an uneconomic point. Cable drilling is generally cheaper than rotary and is used wherever possible, but in competitive areas, rotary is faster and might be used to reach pay formations quicker, even though it is more expensive.

In the rotary drilling method shown in cross section in Figure II, the bit is attached to the lower end of a drill pipe through which mud is pumped to carry the rock fragments to the surface continuously. The flowing mud acts to keep

## ROTARY DRILLING

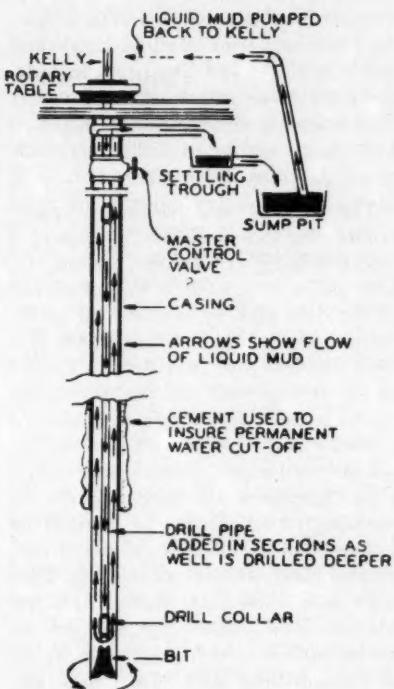


FIG. II

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the hole open and prevent caving of the walls in soft formations. The mud not only removes drill cuttings, but also lubricates and cools the drill. The mud seals off all water seepage, and flows of oil and gas too small for economic production. It also prevents heaving and caving around the drill hole. In addition, the weight of the long column of mud counterbalances underground pressures and prevents drilling tools from being blown out of the hole when high pressures are encountered in the oil sands. In rotary drilling there is no limitation as to depth except that imposed by the strength of materials.

In the early days of rotary drilling, water was pumped down through the drill pipe to raise rock cuttings, and the well was allowed to make its own mud. Now synthetic colloidal mud has become a carefully balanced fluid which is varied in consistency, specific gravity and chemical composition to adapt it

(Continued on Page 4)

# The Engineer in the Oil Industry

(Continued from Page 3)

to varying conditions. Basically, muds consist of water and bentonite clay, but they also contain such materials as barite, phosphate, ground silica, tannic and humic acids, slaked lime, caustic soda, water glass and starch. An improperly chosen mud sometimes causes corrosion and fatigue cracks in drill pipes, with resulting failures.

The engineer still has many opportunities for improving the efficiency of rotary drilling. Under the present system, power is applied at the upper end of the drill pipe to spin the bit at the bottom of the hole. In a 10,000 foot well, the drill pipe may weigh as much as 200,000 pounds and except for the lower sections just above the drill bit is under both tension and torsion, and subject to fatigue, erosion, and corrosion. Engineers are testing means for applying power directly to the drill bit independent of the pipe, which is only rotated slowly to prevent sticking. Tests have been conducted wherein the drill bit has been rotated by a direct-connected turbine, which is activated by the flow of drilling mud. Tests have also been made by rotating the bit with an underground electric motor receiving its power through a long cable. None of these experiments have been entirely successful, but the working out of some such method would be a big step in improving drilling operations. After wells stop flowing because of reduced underground pressure, the oil is raised by pumps. Some deep wells cannot be pumped because the enormously long sucker rods needed for the pump cannot support their own weight. The development of superior pumping means for deep wells would increase production efficiency.

In the constant search for more oil, deeper wells are being drilled, which necessitates increases in weight of drilling equipment and power for its operation. There are sixteen fields with wells producing oil and gas at depths from 12,000 to 14,000 feet. A depth of 20,521 feet has been reached in a Wyoming wildcat well (June 1949). The total cost of drilling this well is close to one million dollars. In 1948, 39,778 wells were drilled in the United States for an aggregate distance of 137,392,000 feet, which is equivalent to

drilling three times through the diameter of the earth.

With the limited technical knowledge available in the past, it was impossible for many years to drill a straight hole. The constant study of drilling methods and the development of new types of bits has made it possible to drill holes within two degrees of the vertical. Directional drilling now makes it possible to run the drill hole at any angle with the vertical and many exploratory wells can be drilled from the same derrick floor. As many as 20 wells have been sunk from one rig in this way whereas only one was possible in the early days. Drilling has been carried out under the Pacific ocean from derricks erected on shore by directing the well out under the sea. In vertical drilling, it is possible to by-pass jammed tools and other obstructions and resume directional drilling below them.

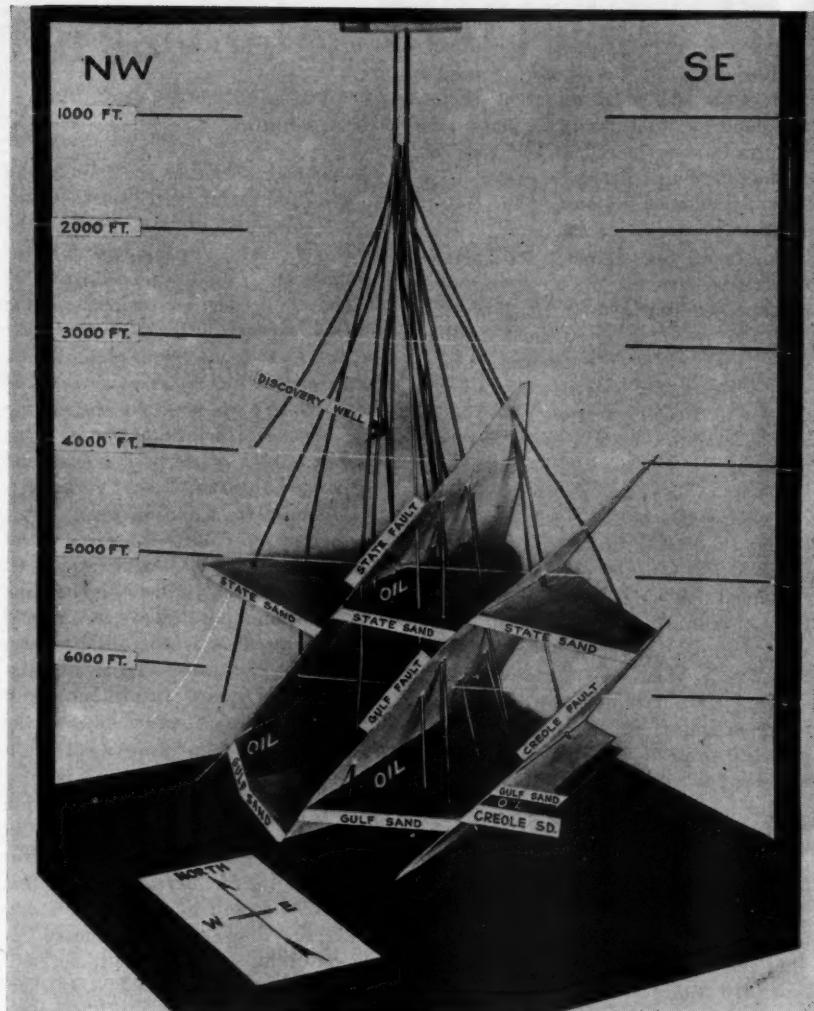
Cementing off undesirable water influx into the well is an important phase of drilling. When water is encountered, a slurry of quick setting cement is pumped through the drill pipe and allowed to set in the hole and around the lower end of the casing. Drilling is then resumed through the hardened cement. Special cements and cementing techniques have reached a high state of development. As cementing operations are improved, and light weight cements are developed, lighter weight casings can be employed. The hole will be uniformly lined with cement which will support the casing and also keep corrosive liquids from contact with it. Recently some plastics have been used in place of cements. The plastics not only seal off water, but also coat the casing and reduce corrosion. The present methods of sealing off water are a far cry from some of the earlier expedients which consisted in the use of flaxseed bags, cotton seed hulls, sawdust and hay which swelled and kept the water back.

## Production

When indications of oil or gas are reached in a well drilled by the rotary method, the procedure in bringing in the well is usually as follows. First the drill pipe and the attached bit are withdrawn, leaving the hole full of drilling mud, except for the volume occupied by the drill pipe, which is replaced to restore it to ground level. At this point, a test may be made by lowering a pipe with an expandable packer and a valve above it through the mud to the bottom of the hole. The packer seals off the

mud and the opening of the valve permits flow of gas or oil and indicates pressure. After this test the valve is closed and the pipe withdrawn. If satisfactory indications have been obtained casing is run to the bottom of the hole and cemented. Then tubing is sunk and water is pumped down through it to displace the heavier mud and force it out to the surface through the annular space between casing and tubing. At this point the well is under reduced pressure and may start to flow. In flowing wells, the oil is forced to the surface by the pressure of gas, water or both. Oil fields are now assured of maximum oil recovery by the regulated spacing of wells and conservation of gas pressure by establishing optimum flow rates. On January 1, 1949, there were 440,000 wells producing in the United States, of which 11.3 per cent were flowing under natural pressure and the remainder were being pumped. The average daily production per well in the United States is about 12 barrels. However, this average includes many old wells yielding only a quarter of a barrel a day on pump, and gushers producing many thousands of barrels under natural flow. In Saudi Arabia, new fields have been discovered, and 50 flowing wells are producing over 500,000 barrels of oil a day, an average of over 10,000 barrels per well.

The flow of oil from wells gradually slackens from its original production because of a number of factors including a gradual loss of gas or water pressure, the retention of oil in rock capillaries, and in some cases the accumulation of wax. At depths below 1500 feet the temperature is high enough to prevent the deposition of wax, but if accumulations occur in shallower wells, the wax can be removed mechanically or by use of solvents such as carbon bisulfide. Numerous devices for increasing the recovery of oil from sandstone and limestone have been employed. The earliest method of stimulating oil flow was by shattering the formations with nitroglycerin explosions, and this is still widely used. In a later variation of this method, a cylinder containing horizontal cartridges is lowered through the casing to the desired depth and the cartridges are simultaneously discharged by electrical means to shoot holes in the pipe and the oil formations. Astounding increases in production have been effected by reacting hydrochloric acid with limestones and dolomites. The acid not only opens up capillaries by reacting with lime and



**Figure IV.** Model showing nineteen holes drilled from a single platform over the Gulf of Mexico. Courtesy of Pure Oil Company.

magnesium, but also creates gas pressure by generating carbon dioxide. As a general average, acidizing doubles oil production rates but much greater increases have been observed. For example a well which was producing 150 barrels a day, produced 1400 barrels after the use of acid and another small well was stepped up from a production of 4 to 140 barrels. Experiments have been made with hydrofluoric and fluoroboric acids on sandstones with occasional benefit.

#### Secondary Recovery

After all engineering technology has been employed to conserve pressure and stimulate oil flow and the well has been kept in production by pumps, there is still oil strongly held in the rocks. The amount of oil varies widely depending

upon the care with which original well pressure was conserved and the character of the oil formation. The oil left below ground may vary from 20 to 85 per cent of the total. If the probable oil recovery seems to be profitable, some of this oil can be recovered by either pumping in water or by using a gas drive. In a field where a number of wells have been drilled, water can be pumped down several well holes surrounding a particular well into which the oil is forced by the water pressure created. If old wells are not available, a number of holes are drilled around the well for water injection. The Bradford field in northwest Pennsylvania is a good example of the benefits of water flooding. This field had a peak production of 31,000,000 barrels in 1891, after which it dropped below 7,000,000 barrels around 1920. Water flooding has

raised production to about 12,000,000 barrels a year and studies indicate that there are 700,000,000 barrels of oil which can eventually be recovered, more than the total production to date of 515,000,000 barrels. This is one of the large conservation steps worked out by the oil industry.

#### Arctic Drilling

Engineering resourcefulness is nowhere better illustrated than in exploration of the United States Naval oil reserve in Northern Alaska. During the brief Arctic summer of 1944, two ships laden with supplies and equipment landed at Point Barrow, and made camp on a completely barren and inhospitable site, where a pebbly beach thawed for only a foot down so that transportation was limited to caterpillar tractors. In the complete darkness of the following January, a motorized trek began to a well-drilling site on the Colville river, 180 miles southeast. Average winter temperatures were thirty below zero and frequently reached fifty below. All equipment had to be completely housed, and personnel specially clothed to withstand the climatic rigors. Drilling mud had to be heated to keep it from freezing. A well was drilled to a depth of 1300 feet, the first 500 of which were perpetually frozen. Indications of oil were found at depths of 200, 500, and 1300 feet. It is a tribute to engineering planning that drilling was accomplished with no equipment failure and no casualties among personnel.

#### Continental Shelf Drilling

Spectacular developments are in progress in the waters of the Gulf of Mexico, where wells are being drilled into the continental shelf 30 miles from shore, in water up to 60 feet deep, to find and produce petroleum. World continental shelves comprise 11,800,000 square miles, about one-twelfth of all present ocean areas, and they are all potential oil producers. Continental shelves of the United States have an area of 750,000 square miles; 129,000 being in the Gulf of Mexico and 40,000 off the coast of California.

Extensive plotting of underground formations in the continental shelf off Louisiana and Texas, through the use of the seismograph and other methods, indicated that the oil-bearing structures

(Continued on Page 6)

# The Engineer in the Oil Industry

(Continued from Page 4)

and salt domes characterizing the shore line areas extended seaward. There was considerable previous engineering experience in overwater drilling, although most earlier wells had been drilled in fresh water lakes. For example, prior to 1920, wells were drilled from platforms erected over Lake Caddo, Louisiana. At a later date, well drilling began from platforms in Lake Maracaibo in Venezuela where wells have been drilled 10 miles from shore in 60 feet of water. Projects had also been completed in the swampy Louisiana areas bordering the Gulf, where reconnaissance work was done by amphibious buggies, and drilling operations were conducted on platforms supported on piles in the shallow waters. To train drillers for work over the Gulf, one company erected apparatus on land, which to a degree simulated that to be used over water.

Engineering difficulties involved in continental shelf drilling in the Gulf are tremendous. Drilling platforms have to be constructed at sufficient height above mean water level to withstand the battering of winds of hurricane velocity up to 125 m.p.h., and waves over 30 feet high. A photograph of the largest of these drilling platforms which cost \$1,200,000 is shown in Figure III. (Shown on front cover of this issue.) It has two decks with dimensions of 206 x 100 feet, supported on 110 ten-inch H-beams, which are driven into the soft Gulf floor from 147 to 197 feet. To guide these beams while they are being driven, tubular steel templets, 16 inches in diameter and 72 feet long, are sunk into the Gulf bottom, the upper half of the templets being covered with special glass fiber anti-corrosion wrapping, since the corrosion of steel by salt water is a major problem. The lower deck of the platform is 32 feet above mean water level and the upper deck is 14 feet above this. The drilling platform is still another 14 feet higher and the top of the derrick rises 136 feet more, so that this man-made structure towers over 200 feet above the water. More than an acre of working space is provided on the two decks, which include living quarters for 54 men. However, on the approach of a storm, drilling crews generally abandon camp and start for shore after lashing down all loose material on the platform.

Figure IV (on Page 5) is a diagram of the wells drilled from one platform off the coast of Louisiana. Nineteen wells were drilled at different angles and depths so that nearly a square mile of area was explored. This type of drilling is particularly necessary over water because of the cost of erecting a separate platform for each well.

Costs and operational hazards have made necessary the most careful engineering planning in both the construction and use of these off-shore drilling sites. Much experience has been gained with wave action hazards. Apparently danger to structures from waves rises as water depth increases to 50 feet, but as the water gets deeper the wave hazards tend to decrease. Steady ocean currents must also be reckoned with, even though they are of low velocity. A man-made island for drilling must be self-contained and have even more facilities than on land. It must include all necessary drilling equipment, tools, repair facilities, warehouses, communication systems and machinery for unloading heavy supplies. It must also have its own fire protection system and a fresh water supply.

The problem of taking care of oil production when drilling over water is of primary importance. Thus far, all production has been transported by barge to land storage. Consideration has been given to the use of undersea pipelines and to either floating or submerged tanks. In regard to the latter expedients, it is difficult to calculate in advance the storage capacity that might be needed and the oil barge seems to be the best solution at present.

Thirty-five oil companies have spent \$38,000,000 on leases, rentals and bonuses for 2,500,000 acres in the Gulf. The drilling of 44 wells has resulted in 6 oil producers and 5 gas wells. The ratio of one producer for every 4 wells drilled is better than the 1 to 5 ratio obtained in wildcat drilling on land. At

present, 25 new wells are either planned or drilled in the Gulf.

## Transportation

In the transportation of crude oil and finished products, the engineer has made major contributions. In the United States, there are now 147,000 miles of pipelines which hold around 35,000,000 barrels of oil. The construction of the Big Inch pipeline in record time during the war, to supply oil to the Atlantic seaboard, was a notable instance of well organized cooperative engineering by a number of private concerns. This pipeline is 24 inches in diameter and runs from Longview, Texas to Phoenixville, Pennsylvania, 1,254 miles away. It can transport 325,000 barrels of oil a day, holds 3,860,000 barrels, and cost \$145,000,000 to construct. The line traverses mountains, valleys, rivers and plains. Since the war, the line has been converted to the transportation of natural gas and is now furnishing about 300,000,000 cubic feet a day to the northeastern states.

The largest of all pipelines is now under construction in Saudi Arabia from Ras El Misha'ab on the Persian Gulf to a point 35 miles south of Beirut in Syria on the Mediterranean. This line will have a length of 1,075 miles, and an average diameter of 31 inches. It will have six pumping stations, and transport from 300,000 to 500,000 barrels of crude oil a day. Without this line sixty-two 110,000 barrel tankers would have to take the long sea route of 3600 miles around the Arabian Peninsula, through the Persian Gulf, the Red Sea, the Suez Canal, and the Mediterranean. Since such tankers would have to return in ballast, their total journey would be 7200 miles for a cargo of oil. The pipeline thus cuts off about 6000 miles of travel. It is planned for

(Continued on Page 18)

Charles B. Burdick      Louis R. Howson  
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# Furnaces for By-Product Fuels

Otto de Lorenzi  
Director of Education  
Combustion Engineering—Superheater, Inc.  
New York, N. Y.

By-product fuels may be broadly classified as those which constitute some of the by-products of various manufacturing processes. Their value as low cost substitute fuels, for steam generation, will depend largely on the manner in which they are prepared and on the use of suitable furnace designs. Perhaps the most widely available of these fuels result from oil refinery operation and the manufacture of steel, coke, lumber, pulp and sugar. Of course, there are many others but their availability is so limited that no attempt will be made to discuss them at this time.

## Oil Refinery By-Products

By-products from oil refinery operations consist of a wide variety of refuse fuels. There are solids such as asphaltic pitch and petroleum coke. The liquids or sludges are often of high specific gravity and contain variable amounts of solid matter in suspension. Refinery gas, blended refinery gas, yard gas and still gas are names applied to some of the gaseous by-products.

## Asphaltic Pitch

When the distillation of oil is stopped somewhat early, there remains a residue which is solid at room temperature, but fluid at still temperature. This residue is asphaltic pitch, with a melting point of about 125°F, and it is usually pumped direct from process to burner at a temperature of 300°F to 600°F. Under these temperature conditions, it is a fluid which is readily atomized, and which can be burned without difficulty. Its properties are somewhat similar to the heavier grades of Bunker "C" oil and therefore furnace design limitations are practically the same.

## Petroleum Coke

Petroleum coke is the solid residue remaining after cracking or carrying

the distillation of crude oil sufficiently far. Its characteristics depend upon the process used. Volatile-matter content varies from 4.0 to 12.0 per cent, and the sulphur and ash also varies widely. Ash-fusion temperature may be as low as 2000°F. Grindability ranges from that of extremely hard and abrasive coke, similar to metallurgical coke, down to one that can be easily pulverized with low power consumption and low mill maintenance. This pulverized fuel is readily burned in water cooled furnaces, provided moderate heat liberation rates, between 15,000 and 22,000 Btu per cu. ft. per hr., are used.

## Acid Sludge

The characteristics of a sludge are governed by those of the crude oil used, and the manner in which it is processed. Much of the suspended solids may be carbonaceous, in the form of small particles of petroleum coke. Continuous agitation and recirculation at velocities high enough to prevent settling out are necessary to avoid plugging of fuel lines.

Perhaps the most widely available and yet most troublesome, because of its frequently varying characteristics, is acid sludge. Its gravity may range between 5 and 14 API, and its viscosity is indeterminate. It contains changing quantities of weak sulphuric acid that may reach as high as 40 per cent and this, together with the suspended carbonaceous material and flux, which must be added in variable amounts to make the sludge flow, causes the heating value to vary between 8,000 and 17,500 Btu per lb. Due to the suspended solid matter it is necessary to use relatively large orifices in the atomizer. As a result atomization is coarse and ignition is not always stable. Refinery practice is to burn the sludge as a supplementary fuel to gas or oil. Each steam generating unit is provided with several combination-type burners, some of which operate, with gas or oil, to maintain ignition and reasonable capacity during

periods when sludge is of erratic quality. The products of combustion resulting from acid sludge burning carry a large quantity of water vapor. Gas temperature, at the outlet of heat recovery equipment, must be well above the dew point if moisture deposit and resulting corrosion of the metallic surface is to be avoided. Maximum furnace liberation rate should not exceed 25,000 to 30,000 Btu per cu. ft. per hr.

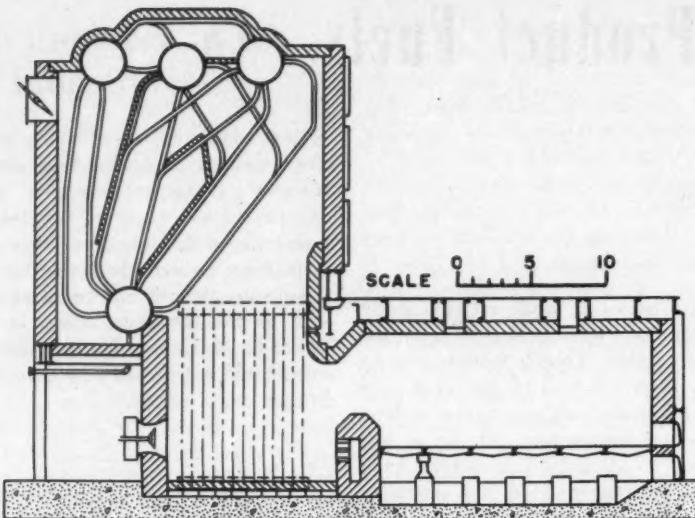
## Refinery Gas

The heating value of refinery gas is higher than that of natural gas, owing to the larger percentage of heavier hydrocarbons present. Its composition is variable as a result of differences in the characteristics of the oil refined and the extent of cracking to which the oil has been subjected in order to extract gasoline. There are also present some illuminants, or unsaturated hydrocarbons from the cracking operations.

For use in steam generating units, the gas from several types of operations are mixed, or blended. The characteristic flame from this blended gas, except for a distinct, clear, blue zone in the area of the burner throat, is colorless and extremely short. At times, however, the gas may be wet and contain some of the lighter phases of gasoline in the forms of mist or vapor, when present these burn with small, intermittent, while flashing flames. These gasolines are undesirable because of their comparatively slow burning characteristics, which result in continuous or secondary combustion that may extend through a large portion of the boiler. As a result, efficiency is lowered because of increased losses resulting from higher boiler exit temperature; and increased maintenance follows because baffles and superheater supports are subjected to abnormally high temperature.

Burners for refinery gas are similar to ones used for natural gas firing, and are also arranged for using auxiliary liquid fuels. The gas ring or tube should be readily replaceable as there may be a tendency for orifice plugging from carbon accumulations when burning contaminated or wet gas.

(Continued on Page 8)



**C-E Steam Generating Unit with long Dutch oven furnace and tandem arrangement of fuel-feed openings.** Courtesy, Combustion Engineering —Superheater, Inc.

Furnace design limitations are the same as those for natural gas firing. Fully watercooled walls may be employed and maximum continuous heat liberation rate should not exceed 20,000 to 30,000 Btu per cu. ft. per hr.

A large eastern oil refinery has installed several steam generating units designed for a continuous capacity of 125,000 lb. of steam per hr. at 800 p.s.i. and 750°F, with initial operation at 450 p.s.i. The fuels are Bunker "C" oil, refinery gas, soda tar, and acid sludge, with provision for future pulverized coal firing. Four horizontal turbulent type burners, arranged to handle any of the fuels, are used. The units are often operated by burning three of these fuels simultaneously. The most frequently used combination is oil, soda tar and refinery gas.

The units have regenerative type air heaters. The furnaces are watercooled and designed for a continuous heat liberation rate of 25,000 Btu per hr. with oil at a corresponding efficiency of 84.3 per cent. With soda tar the efficiency is 85.6 per cent, and with acid sludge 84.8 per cent.

#### Steel Mill By-Products

The two principal by-product fuels from steel mill operation are blast-furnace gas and coke breeze.

#### Blast Furnace Gas

Blast furnace gas results from the various reactions occurring in the differ-

ent zones of the blast furnace. It contains relatively high percentages of carbon monoxide, along with carbon dioxide, nitrogen, and water vapor. It is a lean gas, having a heating value which varies between 90 and 110 Btu per cu. ft. and is dependent on the quality of coke used, the speed of combustion, the ore treated, and many other factors. As this gas leaves the top of the blast furnace it is hot and contains considerable dust having a high iron oxide content. Much of the dust is removed and then sintered for return to the blast furnace as a part of the ore charge.

The extent to which blast furnace gas should be cleaned, for use as a boiler fuel, can only be determined after a careful economic analysis, for each installation, of the many factors involved. The decision whether to burn a dirty, partially cleaned, or a clean gas will have considerable influence on the selection of burners and type of furnace to be employed. The use of hot, dirty gas is feasible even in all-refractory boiler furnaces. On the other hand, in many instances it has been found profitable to clean the gas thoroughly, because furnace outage for cleaning and refractory maintenance are reduced to a minimum.

Blast furnace gas is slow to ignite as it contains a high percentage of non-combustible gas. It is, therefore, important that the burners produce rapid and intimate mixing of this lean gas with the optimum amount of air to assure complete combustion, and at the

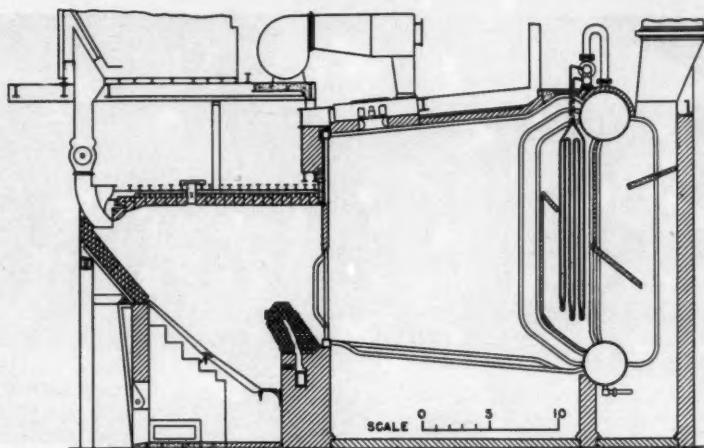
same time maintain stabilized ignition. Preheating the combustion air will serve to accelerate ignition, and permit the use of completely watercooled furnace walls with either washed or unwashed gas. The furnace hearth should be shaded by a water-screen so that any accumulation of dust in that area will not be sintered and thus become difficult to remove. Maximum continuous heat-liberation rates should not exceed 20,000 to 23,000 Btu per cu. ft. per hr.

Four large tangentially fired units have been installed in a midwestern steel mill. The burner located in the corners of a completely water cooled furnace, are arranged for blast furnace gas, and coke oven gas firing. Each burner bank is composed of five fuel nozzles, two for blast furnace gas, two for coke oven gas, and one for a pilot light. The maximum continuous capacity, when burning blast furnace gas only, is 200,000 lb. steam per hr. at 325 p.s.i. and 700°F, at a corresponding heat-liberation rate of 23,000 Btu per cu. ft., and an efficiency of 79.4 per cent. Combustion air is supplied to the burners at room temperature, and, even though the furnace is fully watercooled, the use of tangential firing assures prompt ignition with rapid and complete combustion, when using primary washed gas. The use of a two-drum, integral economizer serves to reduce the exit gas temperature to 500°F, which, together with the low excess-air requirements, makes possible the high efficiency reported above.

#### Coke Breeze

In the manufacture of metallurgical and domestic coke there is always some coke too small even for domestic heating. This by-product is generally known as coke breeze. There is as yet no accepted standard for the sizing of breeze, even in those plants where it is produced. For that reason, no fixed design of furnace has been developed for burning this fuel. Furthermore it is most difficult to ignite because it has a spongy-like structure and a volatile-matter content which lies in the low range of 1.0 to 7.0 per cent. By far the largest quantity burned comes from the manufacture of metallurgical coke and has a maximum volatile-matter content of 2.0 per cent.

Since ignition is the principal factor in successfully burning coke breeze, the traveling- or chain-grate stoker is the most suitable type to use. With these



**C-E Steam Generating Unit for combination firing of pulverized coal and wet-wood refuse from a pulp-mill wood room. Courtesy, Combustion Engineering—Superheater, Inc.**

the fuel is progressively fed to the furnace in a thin, unagitated, slow moving layer which is exposed to radiant heat from suitably placed arches. Ignition is prompt, stable, and penetrates the fuel bed rapidly. The grate is zoned so that the operator may regulate the intensity and flow of combustion air to meet steam demand.

In designing furnaces for burning coke breeze, the rear-arch furnace is employed wherever possible. If the maximum size is  $\frac{3}{4}$  in. to 1 in., the front-arch design is chosen because it has a heat-stabilizing effect on ignition of the fuel. If the maximum sizing of breeze is  $\frac{1}{2}$  in. to  $\frac{5}{8}$  in., the rear-arch design is employed. Minimum sizing, or undersize, or breeze is also of considerable importance because of its effect on carbon loss in ash pit and fly ash. Coke breeze is much lighter than coal and the fine particles lifted from a fuel bed are easily carried out of the furnace with the gas. It can be said, in general, that best results are obtained with coke breeze if it is screened to pass through a  $\frac{1}{2}$  in. or  $\frac{5}{8}$  in. round-hole screen, and contains not less than 20 per cent or not more than 30 per cent undersize of  $\frac{1}{8}$  in. or smaller.

Frequently steam generating units whose principal fuel is coke breeze are also arranged for supplementary firing of either blast furnace gas or coke oven gas. One successfully operating unit of this type has a maximum capacity of 45,000 lb. of steam per hr. at 415 p.s.i. and 650°F which is developed with either coke breeze or coke oven gas. At this capacity, the heat-liberation rate in the secondary furnace for gas firing

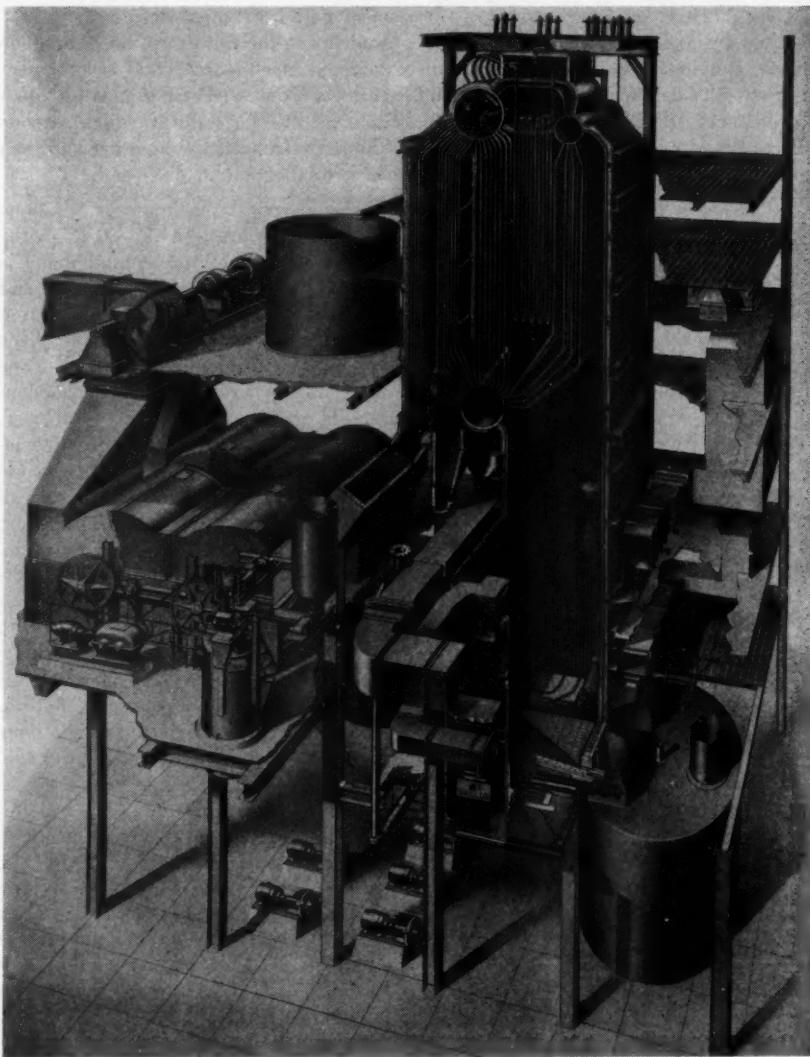
is 25,000 Btu per cu. ft. The stoker area was selected for the conservative burning rate of 30 lb. of breeze per sq. ft. per hr. That rear arch and the frontwall of the secondary combustion chamber are watercooled. Clinker chills are provided along the sidewalls at the stoker grate line.

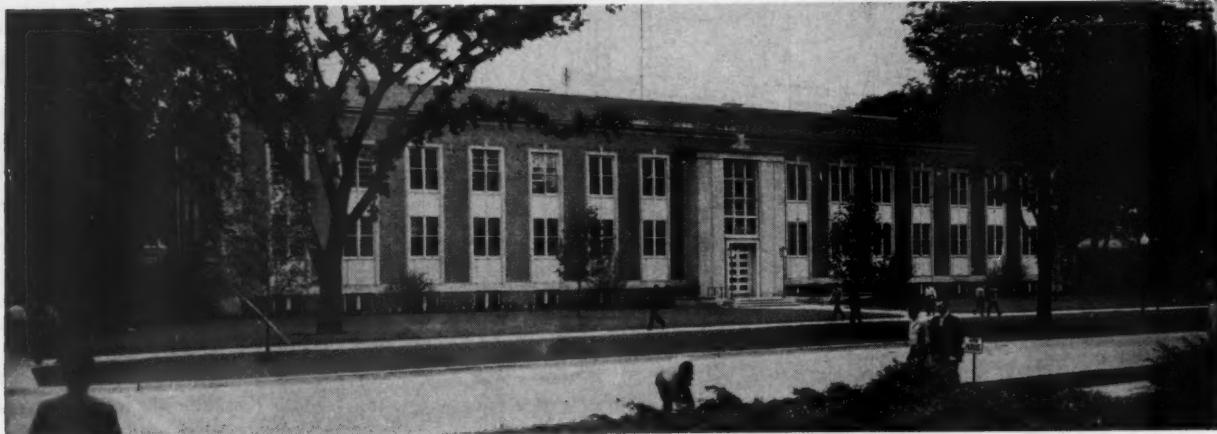
#### Lumber Manufacture

In the vast forest covered areas of our Northwest are located a majority of the lumber industries' largest sawmills. They provide large quantities of wood waste for steam generating purposes. Some of this wood is burned at the mill to supply needed power, while much of the remainder is sold for use in utility and industrial power plants, located within

(Continued on Page 23)

**Cutaway view of C-E Recovery Unit showing design features and structural arrangements. Courtesy, Combustion Engineering—Superheater, Inc.**





The Electrical Engineering Building

## Illini Engineers Finish New Buildings

The College of Engineering of the University of Illinois at Urbana has recently completed two ultra-modern additions to the campus, the Electrical and Mechanical Engineering Buildings. These buildings, of functional design, were constructed as a part of the University-wide program designed to alleviate the overcrowded classrooms resulting from the enormous influx of students during the past three years. The E.E. Building has been in use since September, 1948; the M.E. Building is ready for September, 1949.

Both buildings are designed in a modified Georgian architectural style. Red brick construction with Indiana limestone trim was used to permit harmonious blending of the two new buildings with those immediately nearby. Both buildings are located on Green street with the E.E. Building situated between Wright street and Burrill avenue and the M.E. Building between Mathews and Goodwin avenues.

### Electrical Engineering Building

Built with 213 ft. along Green street and 141 ft. deep, the E.E. Building has three principal entrances located at each side and front of the building. The main entrance at the front of the building opens onto one set of stairs leading down to the ground floor and two other sets on each side leading up to the main floor on which are located the department offices. On this floor also are the servomechanism laboratory, a special illumination classroom, electrical equip-

ment and instrument design rooms for students in the power option, a seminar room, student lounge, and several general classrooms. These rooms all open onto an interior hallway which extends along the front of the building and then back to the rear at each end.

The electrical machinery laboratory, occupying an area 140 by 80 ft. in the central portion of the ground floor, is entirely without outside exposure and is lighted with 50 ft.-c. of illumination by pendant fluorescent fixtures. This laboratory can handle 10 classes at one time, and is equipped with small conference rooms along the north wall, permitting the students to get off the machine floor to discuss problems on experiments. Also along the north wall is a large room which is insulated from the rest of the building by a 16-in. concrete wall and which houses the power supply equipment for the laboratory machines. Immediately to the north of this laboratory are the woodworking, electroplating, arc welding, and machine shops. The rest of the ground floor is occupied by classrooms and offices along the front, along the west side by instrument calibration, repair, and storage rooms with a "dumb waiter" type lift in the storage room to serve the upper floors, and along the east side by the meter-relay laboratory, a freight elevator which extends to the roof, and the stock room. In order to adequately ventilate these large interior rooms on the ground floor, a penthouse on the rear of the roof houses the ventilating equipment.

The top floor which is reached by stairways at each end of the building contains all the communications, electronics, radio, and UHF laboratories along the north side of the main corridor. The first two of these laboratories are equipped with special tables designed to provide all the necessary power sources at each unit. The rest of the floor is occupied by classrooms and some offices.

At the middle of the top floor hallway are stairs leading up to a penthouse which runs partway along the roof. This penthouse houses television and other UHF equipment which are used partly for the study of antenna propagation and receiving characteristics. The associated antennas are mounted both on the penthouse roof and the building roof adjacent to the penthouse.

### Mechanical Engineering Building

The M.E. Building which extends for a total frontage of 211 ft. along Mathews avenue and 244 ft. along Green street can be entered from the Green street side by main doors at the middle of the building and from either side by doors at each end of the main corridor running near the front of the building. Upon entering the building the visitor is greeted by well-ventilated corridors with acoustically treated ceilings, flush-mounted incandescent light fixtures, and tile floor. The walls are of painted plaster with painted metal trim, and all metal fittings are in bronze. The doors

themselves are varnished veneer set in metalwork frames.

In classrooms and all other general rooms painted masonry walls are used. Blackboards are provided with special lighting, and convector type radiators are used throughout for heating. All drafting and design rooms and most of the shops and laboratories are lighted by fluorescent fixtures set diagonally across the ceilings to allow greater freedom in the placement of work tables and machines. Acoustically treated ceilings are also used for lecture rooms and other special rooms. Ventilation for the building is provided by a mechanical draft ventilating system located on the roof.

The building itself consists essentially of two divisions. At the rear a section consisting of two 20-ft. stories houses most of the laboratories and shops. The first floor is predominated by the internal combustion and turbine laboratory, and across the hall is a small lecture room. Several other research and instruction laboratories including the heat treatment of metals laboratory are also located on this floor along with a large locker and wash room which serves all the shop area and permits the student to change clothes while working in the laboratories. On the second floor is a large machine tool laboratory served by an overhead tram system which extends outside the building to permit the hoisting of machines from the ground. This track system also runs above a special turntable located in the adjacent lecture room which can be used for demonstrating actual equipment. Opening onto the main machine shop floor are the associated stock, tool and gage rooms. In addition there is also the welding and metal cutting laboratory located across the hall from the lecture room.

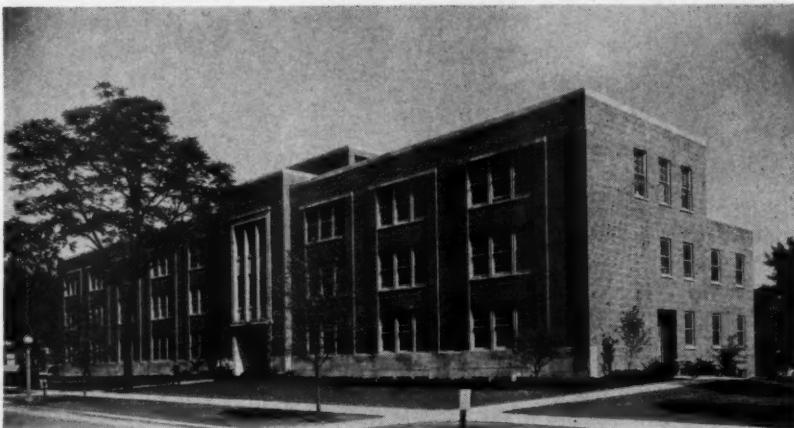
The main division of the building is separated from the section just described by a center section consisting of two stories and a basement, and housing offices along both sides of the corridors. Since the floors of this section are vertically displaced from those of the laboratory and shop section, short flights of stairs join the two sections. The main division, consisting of three stories and basement, contains offices and classrooms along the southern or front portion of the building with the larger rooms and laboratories along the north side facing an inner court. In the basement are the instruments and controls laboratory, the fuels and lubricants lab-

oratory, the heat transfer laboratory, and thermodynamics laboratory, along with several classrooms, offices, and an equipment construction shop. On the first floor near the main entrance are the well-appointed department offices and the spacious student lounge. The tool design room and several modern classrooms, lecture rooms, and two seminar rooms complete the rest of the first floor.

A lecture room and a seminar room are located on the second floor. Also on this floor are the motion and time study laboratory, the precision measurement and gage laboratory, and the machine design laboratory. The balance of the floor is occupied by offices, and classrooms. Most of the drafting and design rooms are located on the third floor, there being about 10 such rooms in the building. A special room for displaying models used in design is also located on this floor, while the rest of the floor is devoted to regular classrooms and offices.

**1. The electrical machinery laboratory which can accommodate ten sections, consisting of eight to ten three-man squads.**

**2. The Mechanical Engineering Building.**



Although the additional space and excellent facilities provided by the new E.E. and M.E. buildings have helped enormously to improve both teaching and learning conditions in the two largest departments of the college, they have removed these conditions only from the realm of the impossible. With the present enrollment, from which there is apparently to be little respite in the foreseeable future, these new facilities are even now crowded. If additional increases in enrollment require expansion, it can be carried out easily for both buildings, by building into areas provided for in their original designs.

**WSE Dining Room**

The Western Society Dining Room has resumed complete dining service, featuring lunch from 11:30 to 2 p.m. and dinner from 5:30 to 8 p.m. Guests will have their choice of luncheons and dinners from a selective menu, as well as salads and sandwiches. The buffet luncheon has been discontinued.

# WSE Reviews Year, Installs New Officers at June Dinner

Western Society's Annual June Dinner, held June 6, featuring Colonel Jack Major in a humorous talk on "Taxes, Women and Hogs," entertained the 500 guests and closed the year on a cordial note.

Verne O. McClurg, WSE president for 1948-49, greeted the guests and summarized the activities of WSE during the year. Gustav Egloff, the incoming president, acknowledged the work of the officers during the past year, and introduced the new committee chairmen for 1949-50.

Mr. McClurg, after his opening remarks, introduced the members of the Board of Direction as follows:

"Ludwig Skog, senior partner in the engineering firm of Sargent and Lundy, and newly elected Trustee of the Society.

"Fred Whiting, Vice President of the Westinghouse Company, and also a Trustee.

"William V. Kahler, Vice President of Illinois Bell Telephone Company, Past President and member of the Board of WSE.

"Leroy Bernhard, also an engineer of the Illinois Bell Telephone Company, and a newly elected Trustee.

"Eldon Imhoff, Management Assistant, Chicago Transit Authority, and a Trustee of our Society.

"Donald Becker, Chief Structural Engineer for A. J. Boynton and Company, and our Treasurer.

"J. C. Witt, consulting engineer, and our Second Vice President.

"Herbert Sedwick, Vice President of the Public Service Company of Northern Illinois, and our First Vice President."

Two of the Trustees, Wilfred Sykes and Charles De Leuw were not present.

## Introduces Life Members

After introducing the members of the WSE staff, Mr. McClurg presented Life Membership diplomas to members of the Society who have reached the age of sixty years, and have paid dues for thirty years. He said, "During the past year, sixty-one of our members have attained the enviable status which enables them to enjoy all privileges of membership without having to pay yearly dues."

"It seems to me that our present membership is deeply indebted to these men

and those who will attain Life Membership during the next ten years," he stated "because their continued support and wise management was in large measure responsible for the fact that our Society was able to carry on its activities during the trying depression years. Their continued support also has helped to make it possible to keep intact our reserve fund of investments in securities which was built up before 1929."

He introduced the new Life Members who were present. They included W. F. Arn, Charles C. Brooks, Frank H. Cramer, A. Epstein, Joshua D'Esposito, Alfred Herz, Erwin M. Lurie, J. deNavarre Macomb, George B. Massey, Donald H. Maxwell, Wm. M. Park, Horace P. Ramey, I. L. Reynolds, Norman J. Richards. (New Life Members who were not present are listed on Page 31.)

## Presents Chanute Medal

Mr. McClurg continued his part of the program, stating, "My next pleasant duty is the presentation of the Chanute Medal for this year. This award was established by Octave Chanute when he was president of the Society in 1901 and is given for the most meritorious paper presented during the year. This year the Board of Direction has approved the recommendation of Chairman I. F. Stern, and the remainder of the Awards Committee, that it be awarded to Daniel V. Meiller for his paper in mechanical engineering, entitled *Storage of Natural Gas in Underground Pipe Sections* presented on January 26, 1948 and published in the March, 1948 issue of our Journal."

"Mr. Meiller, it gives me pleasure to present to you the Octave Chanute Medal for 1948-49," Mr. McClurg concluded. Mr. Meiller presented a short response.

"Another pleasant duty and honor," continued Mr. McClurg, "is the presentation of two Honorary Memberships in our Society. According to our Constitution, an Honorary Member shall be a person of acknowledged eminence in engineering, or in a science related thereto, or who has rendered outstanding service to the engineering profession. It represents the highest honor our Society can confer. There are at present ten living Honorary Members. The names of Fred G. Gordon and Arthur Bessey Smith are



Dr. Gustav Egloff

to be added tonight to bring the number up to twelve."

In introducing the first recipient he stated, "Mr. Gordon was born in Fort Collins, Colorado, and obtained his engineering education at the University of Illinois. After graduation in 1912 he entered the employ of Dabney H. Maury, Consulting Engineer, and in 1924 became a partner in the firm of Maury and Gordon, specializing in the field of municipal and sanitary engineering. After retirement of Mr. Maury, Mr. Gordon continued to practice as a Consulting Engineer in the same field until 1941, when he accepted a position with the Department of Public Works of the City of Chicago on the design of the South District Filtration Plant. At present he holds the position of Assistant City Engineer in charge of filtration plant design. His work in sanitary and municipal engineering has brought him national recognition."

He continued, "Mr. Gordon has also given time and effort unsparingly to the activities of this and other engineering societies. He has served on many of our committees, was on the Board of Direction for seven years and was President for 1942-1943."

"Mr. Gordon, it is my privilege to present to you this certificate of Honorary Membership."

Introducing the other recipient, he said, "Dr. Arthur Bessey Smith was born in Iowa, attended the University of Nebraska, and graduated from Purdue University in Electrical Engineering. He received his Ph. D. at Northwestern University in 1926. He began as a telephone repairman, inspector, local man-

ager, wire chief, and engineer of various independent telephone companies from 1901 to 1905.

"He was Assistant Professor of Telephone Engineering at Purdue University in 1905 and taught there for a number of years. Then he went with the Automatic Electric Company of Chicago as a Research Engineer. He has been their Chief Research Engineer since 1909. He also is noted as an inventor, author, and editor. He has been a very active participant in the activities of this and other engineering societies. Dr. Smith is unable to be with us tonight and his certificate will be mailed to him."

#### Summarizes Year

Mr. McClurg stated, "Another provision of our Constitution is that the President report on the general condition of the Society at its annual meeting. During the past year I have come to realize the importance of such a provision because the reports of previous years have been a great help to me.

"However, it seems to me that to present a full report tonight with details of the year's work of all committees and technical sections would prolong this meeting unduly. I have therefore decided to summarize it briefly now, with the understanding that the whole report will be turned over to the Board of Direction and will be published in a fall issue of MIDWEST ENGINEER. I now have almost all of the annual reports of committee, section, and division chairmen. Each of them was requested to make constructive suggestions as to how the Society can better serve its membership and I am truly surprised at the many worthwhile suggestions received. I am quoting liberally from these reports in the following summary."

"A year ago tonight," Mr. McClurg said, "I submitted a list of objectives to be met during this administration. Among them were the following items:

"1. Completion of construction work on the new headquarters at 84 East Randolph Street and installation of the necessary furniture and equipment.

"2. Publication of our new magazine, MIDWEST ENGINEER, in lieu of the former Journal and Bulletin.

"3. Modification of our technical meetings, especially by an attempt to provide more programs of broad general interest rather than with limited technical scope.

"4. Promotion of the use of our quarters as an engineering and science center by other groups and organizations with similar interests.

"All of these aims have been accomplished," he said.

"Construction work on our new quarters was started early last summer and was substantially completed just four months ago," Mr. McClurg stated. "The dining room on the fifth floor, the lounge on the sixth, and the meeting rooms on the seventh are undoubtedly as fine as those of any engineering society in this country. Our membership can well be proud of them and must have a feeling of satisfaction at having been instrumental in making them a reality. Special credit should be given to O. G. Smith, chairman of the Headquarters Committee, who carried on so ably the work started by his predecessor, Gordon Fox."

"The first issue of MIDWEST ENGINEER was published last September," he stated. "It also has been a success and the fine work of Leroy Bernhard and the remainder of the Publications Committee, as well as that of Mrs. Andrews of our staff, deserves special mention. I would like to read to you two sentences from Mr. Bernhard's annual report because he expressed the aim of the magazine better than I possibly could:

"Our editorial objective has been the presentation of technical and semi-technical subjects in a simple understandable manner for members and general readers. It is our ambition to print

material which will tend to make its readers better all-around engineers as well as to help them become specialists in their particular fields."

Mr. McClurg continued, "The acceptance and use of our new headquarters as an engineering and science center by other similar groups already is a settled thing. More than fifty other organizations are using it regularly or for special meetings.

"A recommendation of the General Program Committee, which has been carried out by our ten technical sections, was for each to present three technical programs, one of which was to be on a subject of general interest to all members. However, the attendance has not been too satisfactory at many of these meetings, especially from last September to February while construction was going on. As a matter of fact, all activities of the Society, including the routine functions of the staff, were severely handicapped during the whole construction period."

"Another reason for low attendance at some meetings," Mr. McClurg said, "is that advance notices of meetings have not been as effective in MIDWEST ENGINEER, which is published monthly, as the notices were in the former weekly bulletin. Late in the year, postcard notices were sent out when it was

(Continued on Page 29)

Seated, left to right, Ludwig Skog, F. T. Whiting, W. V. Kahler, V. O. McClurg. Standing, left to right, E. A. Imhoff, D. N. Becker, Gustav Egloff, H. P. Sedwick, L. F. Bernhard.



## CRERAR LIBRARY

### Notes and News

More than two years have passed since The John Crerar Library and the Western Society of Engineers began active conversations concerning the possibility of developing a science and engineering center around the Crerar Library. The signing of the lease covering space for new headquarters for WSE took place on December 3, 1947. In March of 1948, an agreement was reached for the deposit of the WSE library with Crerar. A brief summary of present arrangements will be of interest to WSE members.

Because of the lack of space in the Crerar Library, the bulk of the WSE collection was placed on storage shelves in the Newberry Library. Only those volumes were kept in The John Crerar Library which did not duplicate materials in the Crerar collections.

The catalog of the WSE library is maintained in the Society's headquarters office. Books listed in this catalog may be borrowed from the Crerar Library by members of WSE for a two-week period, with the Society assuming responsibility for the return of the books. Requests left at the headquarters office are forwarded to the Stack and Reader Department of the Crerar Library and the books are delivered to the headquarters office where they may be obtained by the members requesting them.

This procedure applies only to those books which were formerly available from the Society's library for home use. Bound periodicals formerly maintained only for reference use in the Society's library are available for similar use in the Technology Department of the Crerar Library. When Crerar volumes are not available for any reason, the copies in the Society's collection will be obtained from the storage shelves in the Newberry Library.

\* \* \*

For the members of WSE who are not already familiar with the move, attention is called to the fact that scientific and engineering periodicals formerly located in a periodical room on the 12th floor of the Library are now located in the reading room of the Technology Department on the 14th floor.

\* \* \*

The development of the science and engineering center gains new stimulus by establishment in the Crerar Building

## Midwest Engineer Starts Second Year

With this issue MIDWEST ENGINEER begins its second year of publication. Much has been accomplished in one brief year to attain its present position in the engineering field. In the opinion of many competent critics its makeup and typography make it outstanding among engineering society periodicals.

We of the Publication Committee, however, realize that definite improvements can be made in reading matter and in general service to the Society and the engineering profession. With the aid of the committee and section officers and of the general membership we propose to institute these improvements.

MIDWEST ENGINEER, besides its engineering coverage, has essential Society functions to perform. We recognize the definite responsibility not only to present to the membership the technical papers given before the Society, but also the responsibility of welding our increasing membership, engaged as it is in scores of technical activities, into one united society serving the entire profession. This we propose to accomplish by the publication of articles more closely related to the various phases of the engineering profession. These will include all of the more important papers presented before our Society as well as original papers on subjects of interest to us as engineers and as citizens.

Our success depends on the action of the Program Committee in providing manuscripts of papers presented before the Society and of the Publication Committee in producing from its own sources articles of a civic or semi-technical nature. \*

Further, we propose the addition of a news and personals section. The success of this endeavor will depend largely on the cooperation of the entire membership in providing tips on recent developments either of an engineering or of a personal nature which we as engineers and as members of Western Society of Engineers should know.

As another added feature MIDWEST ENGINEER, with the assistance of the Engineering History Division, will present in each issue a brief historical sketch of one of our "Engineering Greats," Western Society members who have contributed generously to the growth of the Society and the engineering profession.

Your constructive suggestions toward a more useful MIDWEST ENGINEER are solicited. You may be assured that each suggestion will receive personal consideration to the end that MIDWEST ENGINEER may be without peer among engineering society publications.

Arthur W. Howson

Chairman, Publication Committee

## Refresher Course to Begin September 12

The pre-examination refresher course for engineers will be held beginning September 12 and ending November 28, 1949, just preceding the examination to be held early in December. The class will meet in Room 65, University of Illinois, at Navy Pier in Chicago, on Mondays and Thursdays between 7 and 9 p.m. The sponsors are the A.S.C.E., A.I.E.E., A.S.M.E., A.I.M.M.E., Illinois Engineering Council and the Western Society of Engineers.

The course will be given by the Division of University Extension of the University of Illinois in cooperation with the Navy Pier Branch, Illinois Institute of Technology and Northwestern University.

Persons who have already submitted their names to any of the above organi-

zations or to the University Extension Division, LaSalle Hotel, Chicago 2, Illinois, will be given the first opportunity to take the course. The class will be limited to 100 students.

Registration will be held in room 65, Navy Pier, on Thursday September 8 between 6:00 and 8:00 P.M.

The tuition fee for this course will be \$16.50 which should be paid at the time of registration. Veterans who are taking this course under the G. I. Bill should present their certificate of eligibility and entitlement on the night of registration. This certificate can be obtained at your local Veteran's Administration office.

Organization of the course will be materially aided if those persons wishing to take the course will contact the University Extension Division, LaSalle Hotel, if they have not already done so. The telephone number of the Extension Division is RA ndolph 6-7750.

of offices for the Chicago Chemists Club and the Chicago Section of the American Chemical Society.

## J. Harrington Named Secretary of WSE

The Board of Direction announces the election of J. Earl Harrington as Executive Secretary to succeed Donald V. Steger, effective August 17, 1949.

Mr. Harrington was born in Chicago and enjoys a wide acquaintance among engineers of the area. Following his graduation from Illinois Institute of Technology he served as Chemical Engineer and Engineer of Tests for the Bureau of Engineering of the City of Chicago.

During World War II he was consultant and engineering coordinator for the Quartermaster General and later served as Chief of the High Explosives Manufacturing and Raw Materials Divisions of the Explosives Branch of the Ordnance Department. Mr. Harrington entered private consulting practice at the close of the war.

Mr. Harrington joined the Western Society of Engineers in 1937 and was a director of the Chemical and Metallurgical Section from 1939 to 1942, serving as Chairman in 1941-1942.



J. Earl Harrington

In 1939 he received the honorary degree of Ch. E. from Illinois Institute of Technology.

Prior to his election as Executive Secretary he was associated with Colonel F. H. Miles in engineering and development work.

## Western Society President, Member Speak to U. N. Scientific Conference

Dr. Gustav Egloff, president of the Western Society of Engineers, spoke before the scientific conference on the conservation of resources of the Economic and Social Council of the United Nations on Tuesday, August 30.

He told the conference that nearly all oil companies are expanding their research activities and increasing their staffs of engineers, chemists, and physicists. He added that in addition to the fundamental supply of fuels and lubricants, the industry is now carrying on vigorous research in agricultural problems, synthetic rubber, plastics, detergents, and other natural and synthetic products.

John T. Rettaliata, Dean of Engineering at Illinois Institute of Technology, and WSE member on the Washington Award Commission, also addressed the conference. He discussed the status of our natural gas, petroleum and coal resources.

## Western Society Personalities in the News

James D. Cunningham (M'20), president of Republic Flow Meters Company, has recently returned from a tour of European industry.

Wm. S. Kinne Jr., (A'44), has been elected secretary of the Chicago chapter, American Institute of Architects. At the organization's June meeting, featuring the presentation of awards, an honorary associate membership was awarded to Dr. Henry T. Heald (A'30, M'34), president of Illinois Institute of Technology.

Clarence B. Pettersen (A'28, M'47), is the new vice chairman of the Chicago Section of the Illuminating Engineering Society.

The following WSE Members have been appointed to the City Planning Advisory Board by Mayor Kennelly: C. H. Mottier (M'20), William T. Reace (M'48), Robert C. Verity (M'48), Otto K. Jelinek (M'36), H. Evert Kincaid (Aff'46), Gerhardt F. Meyne (M'47), George J. Trinkaus (M'19), and William O. Batchelder (M'20).

Freyn Engineering Company, has been purchased by the Koppers Company, Inc. of Pittsburgh, Pennsylvania.

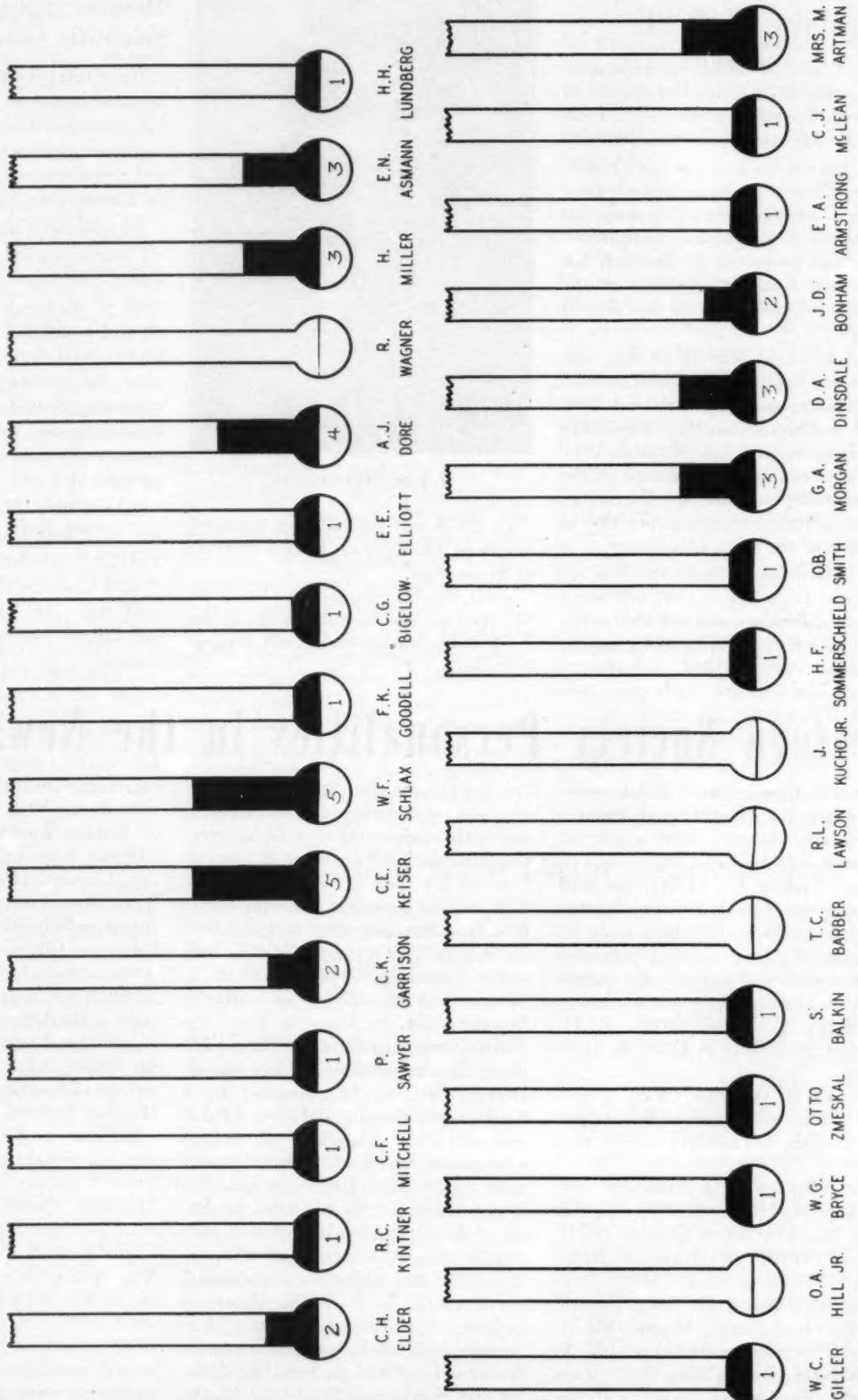
The engineering firm specializes in design and construction of blast furnaces, and in the engineering of mills, and certain other steel mill facilities. E. Gordon Fox (M'21), and a Past President of WSE, is Vice President of Freyn. Other WSE members associated with the firm are William B. Ferguson, (M'48), Wilfred C. Schofield, (A'23, M'31), E. J. Westcott (A'26, M'34), and M. F. Young (A'48).

Miss Georgiana Peeney (J'29, A'36, M'46), has received one of the highest awards that can be presented to a Northwestern alumnus, the Merit Award, presented "in recognition of worthy achievement which has reflected credit upon Northwestern University and each of her Alumni." She was cited for her record in engineering as follows: B.S. (Engineering), Northwestern University, 1929; I.E. (Master's in Industrial Engineering), N. U., 1929. Began as engineer with Curtice Lighting, Inc. Chicago, 1929-1931; engineer, Victor S. Pearlman Co., Chicago; free lance drafting and engineering, Evanston, Illinois, 1932-36; engineer, Dept. of Public Works, Evanston, Illinois, 1936-1942;

engineer, Office Chief of Ordnance, U. S. Army, 1942-1946; engineer, Dept. of Public Works, Evanston, Illinois, 1946-47; engineer, Lansing B. Warner, Inc., Chicago, 1947 to present. During World War II served as engineer and assistant section chief in Safety & Security Division, Office Chief of Ordnance, Army Service forces; now on "Ammunition Know-How" list of the Department of the Army, subject to call in case of a national emergency. Awarded Silver Medal and Award of Merit by the Society of American Military Engineers. Member Western Society of Engineers (chairman professional women's division, vice-chairman publications committee), Society of American Military Engineers, American Ordnance Association; member, Sigma Sigma Delta.

The Howard & Gould Company, 105 West Adams Street, has been formed to consolidate the manufacturers' agencies of Carl G. Howard (J'26, A'29-34, M'36) and John P. Gould, representing several manufacturers of electrical and electro-mechanical products in the railway, utility, communication, and industrial fields.

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**50**

New Applications (to August 22)

## The Engineer in the Oil Industry

(Continued from Page 6)

completion by the fall of 1950. The estimated cost of \$200,000,000 is being furnished by private U. S. capital.

Of all the methods of transporting oil, that by water is usually the cheapest. The construction and operation of oil barges and tankers pose special problems for the marine engineer. The world seagoing tankers now number close to 2,000 with a total capacity of 165,000,000 barrels. Since the war, about 40 per cent of this fleet is under U. S. registry, and there is 10 per cent each under the flags of Great Britain, Norway and Panama. The capacity of the world's tanker fleet will be greatly expanded on the completion of 14 super tankers now under construction. Each of these ships will hold 228,000 barrels and will have a speed of 18.5 m.p.h. Two tankers recently launched in Virginia are the largest in the world. Each holds 255,000 barrels, and has a speed of 20.3 m.p.h.

### Storage

The engineer has developed many types of improved storage facilities for petroleum and its products. The wooden tanks used in the early days of the industry have given place to those of steel and concrete. The largest of the standard steel cylindrical tanks is 168 feet in diameter and 48 feet high, and holds 190,000 barrels of oil. Many devices have been designed to prevent vapor losses from crude oil and gasoline, which may amount to 5 per cent of the liquid volume a year in ordinary tanks. One early device was a balloon,

into which the vapors expanded during the day and returned to the tank at night. Other tanks were provided with vapor domes to house the expansion balloon. Some tanks were constructed with flexible roofs, but they tended to develop cracks and their use was not continued. The devices which have survived the test of time are the expansion roof and the floating roof. The former dips into a liquid seal and rises and falls as the tank vapors expand and contract. The floating roof rests directly on the oil and keeps down vaporization. Other striking developments in tanks for storing volatile liquids under pressure are the spherical and spheroidal types. Spherical tanks are now made with diameters up to 65 feet; the largest tank holds 25,000 barrels under 50 p.s.i. working pressure. The largest hemispherical or "pancake" tank is 155 feet in diameter and 40 feet high. This tank holds 120,000 barrels, and is designed to store liquefied petroleum gas at 5 to 20 p.s.i. The advantage of these tanks is that in the summer they can store the excess production of light hydrocarbons which are not needed in gasoline and keep them available for adding to gasoline in winter to increase its vapor pressure and consequently its ease in starting.

Concrete oil reservoirs have been constructed to take care of crude oil production and to store naval fuel oil in accessible locations. The majority of these have been on the surface of the ground, but some have been constructed underground. Some of these reservoirs hold a million barrels of oil. This type of construction is cheap but it has disadvantages. There is a tendency for cracks to develop through which oil is lost and in earthquake areas, concrete reservoirs are subject to extensive damage.

### Refining

The application of sound engineering principles is nowhere more in evidence than in the refining of petroleum. U. S. refineries have a daily capacity of about 6,100,000 barrels of crude oil. The plan and layout of a refinery, with the design and erection of the mammoth units which characterize many modern plants, call for the services of engineers of many types. Civil, mechanical and structural engineers are necessary to locate and install stills, fractionators, reaction chambers, pumps, compressors and pipe systems. Combustion engineers design furnaces for oil heaters. Chemical engineers calculate plants for special alloys and other materials and correlate process data. Electrical engineers are responsible for power and lighting, and the design and operation of instruments for process control.

The primary operation in an oil refinery is fractional distillation, and here the engineer has developed improved apparatus and processes. In the primary distillation of crude, the oil is heated to about 700°F. during passage through a pipe coil heater and then discharged at approximately atmospheric pressure into a fractionating column. Gas is obtained from the top of the column; gasoline, kerosene and gas oil as side streams at successively lower levels; and residuum from the bottom. The largest fractionating column in the world is at the Abadan refinery in Iran. This fractionator is 30 feet in diameter and 140 feet high and can fractionate 120,000 barrels a day of crude oil into gasoline, kerosene and fuel oil. In some refineries, in addition to the fractionation of crude oil at atmospheric pressure, the residuum from the fractionator is distilled under vacuum to obtain maximum yields of gas oil for cracking, lubricating oil distillates, and either fuel oil or asphalt.

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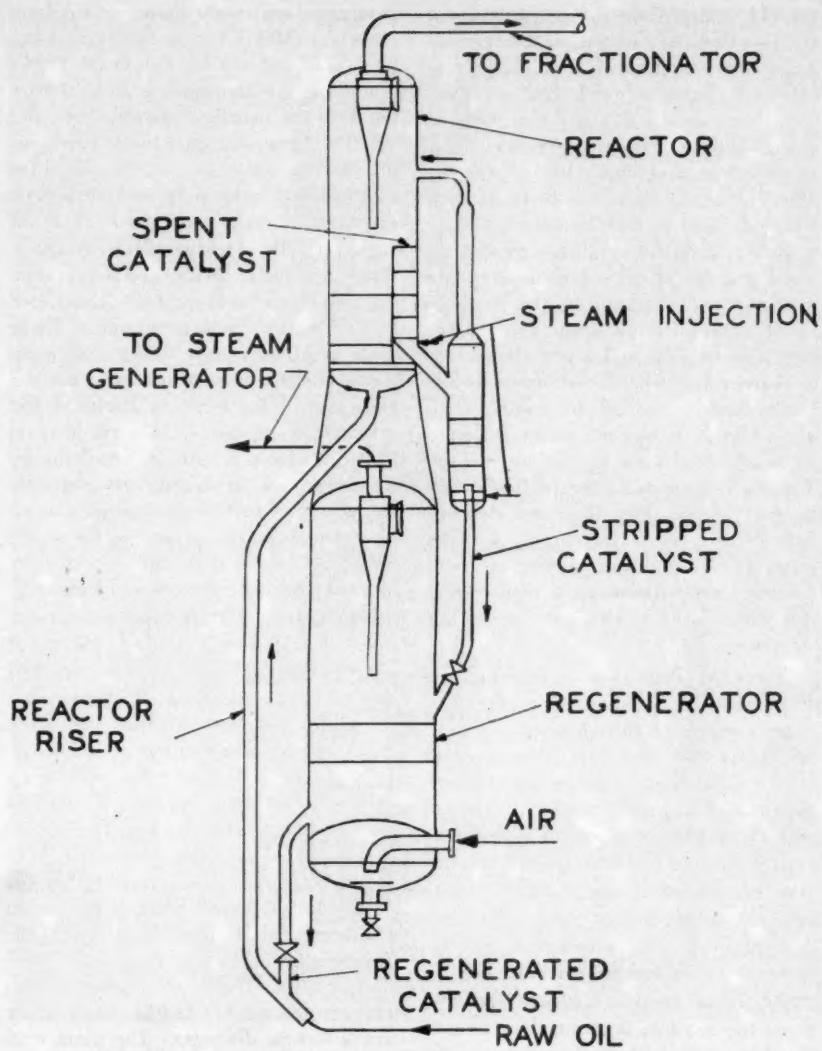
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**FLUID FLOW CATALYTIC CRACKING  
FIG.-V**

COURTESY UNIVERSAL OIL PRODUCTS CO.

The operation known as precise fractionation is applied to many refinery separations. In such fractionation, the column is insulated to minimize exterior temperature influences, and temperatures, pressures, and flows of liquids and vapors are automatically controlled with great accuracy. This operation enables the separation of fractions of narrow boiling range and the recovery of individual hydrocarbons from gas mixtures. The use of azeotropic and extractive third-component distillation for more accurate separation of individual hydrocarbons has become an established practice.

#### Cracking

The thermal cracking process which went into commercial operation in 1913, has been a triumph of engineering development. To operate the cracking process, temperatures and pressures above previous oil industry practices were necessary. The engineer was originally called upon to design cracking stills that could be operated safely at temperatures of over 720°F and pressures of 75 p.s.i. In the Burton cracking process, which was the first to be operated on a commercial scale, gas oil was distilled under pressure in riveted shell

stills. The distillation had to be stopped after 24 to 36 hours because of coke deposits in the still. The coke was then cleaned out and another batch of fresh oil pumped in. The Dubbs process was a tremendous step forward, since by its use heavy residual oils as well as gas oils could be cracked in a continuous operation. In this process, the oil to be cracked was pumped through a pipe coil heater and discharged into a reaction chamber. From the bottom of the reaction chamber, all products were released into a flash chamber in which vapor and liquid products were separated. Flash chamber bottoms were withdrawn as fuel oil and the vapors were passed to a fractionator, where they were separated into gas, gasoline, and incompletely cracked oil which was pumped back for further cracking. In another method of operation, oil was cracked into gas, gasoline and coke which was allowed to accumulate in the reaction chamber until it was completely filled, at which time the run was stopped and the coke removed. The vapors from the reaction chamber were split up into gas, gasoline and recycle oil. A modern plant operating on heavy oil ran continuously for 213 days before a voluntary shut down. Some modern cracking plants such as those that reform gasoline and naphtha are designed to operate at temperatures of 1000°F and pressures of 1000 p.s.i. The first reaction chambers were the riveted type. Later models which had to withstand pressures of 500 p.s.i. have been forged or fusion welded. In severe service, stainless steel heating tubes are employed to prevent corrosion by high sulfur oils. Careful periodic inspection of plants has minimized operational hazards.

The octane rating of thermally cracked gasoline averages about 68. The charging capacity of U.S. thermal cracking plants is about 2,225,000 barrels daily, and the cracking of this oil yields 900,000 barrels of gasoline.

The engineer has been much in evidence in the development of commercial catalytic cracking, which is now the key process in oil refining. In the first commercial plants the catalyst was used in the form of granules in multi-tubular reactors through which the preheated oil vapors were passed to effect their cracking. The original catalysts were bentonite clays. After a period of operation carbonaceous deposits reduced

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## The Engineer in the Oil Industry

(Continued from Page 19)

the catalyst activity, and the stream of oil vapors was diverted through active catalyst in another reactor, while the spent catalyst in the first reactor was being reactivated by air. The cracking reactions are endothermic, and the oxidation reactions during regeneration are exothermic, and difficulties were encountered both in heat transmission and heat distribution in each step. To absorb the heat of oxidation, and keep catalyst temperatures below a point corresponding to permanent deterioration, molten salts consisting of mixtures of sodium nitrite and sodium nitrate were circulated around the tubes in which the catalyst was undergoing regeneration and then around the cracking tubes. The excess heat was used to generate steam for plant use. The use of liquid nitrates in close proximity to hot oil was a daring operation, because of the danger of explosions, if any leaks should develop and the nitrates should come in direct contact with the oil. However, good engineering solved this problem, and no accidents happened. The fixed bed catalytic cracking process has been largely superseded by processes in which the catalyst is kept in motion both during cracking and regeneration.

In the T.C.C. process small catalyst spheres or beads gravitate slowly downward in a reactor through which oil vapors are passing to be cracked. Hot spent catalyst is raised either by bucket elevators or pneumatically to a regenerator wherein it again gravitates downward counterflow to a stream of air for burning off carbon.

The outstanding development in catalytic cracking is the Fluid Flow proc-

ess. The name of the process stems from the fact that the catalyst, in the form of a powder or microsphere, flows and otherwise behaves much like a liquid. The operation of this process, with its many unusual features presented new engineering problems. In the reactor where cracking occurs, a body of such finely divided catalyst is maintained in a highly turbulent condition by the upward passage of oil vapors undergoing cracking. The carbonized and partially spent catalyst flows from the reactor into a down pipe, and is introduced into a regenerator where carbonaceous deposits are burned off by contact with air while it is again maintained in a turbulent fluid state by the air stream. The hot regenerated material flows back to the reactor inlet line and delivers part of its heat to incoming oil. This method of operation minimizes heat transfer and temperature differential difficulties which characterize earlier processes.

Figure V (Page 19) is a diagram of a Fluid Flow catalytic cracking plant and a photograph of such a plant is shown in Figure VI. The gas oil is pumped into a line which receives hot regenerated catalyst, and carries it upward into the bottom of a reactor. Inside the top of the reactor is a cyclone separator through which the cracked vapors and entrained catalyst pass. The catalyst particles are thrown out by centrifugal force and returned to the reactor. Spent catalyst continuously flows from the reactor, is steamed to remove adhering oil and transported to the regenerator where air burns off carbon deposits. A cyclone is also used to recover catalyst from the regenerator gases.

In thermal cracking, much higher pressures and somewhat higher tem-

peratures are used than in catalytic cracking. Maximum pressures in catalytic cracking are of the order of 15 pounds above atmospheric and the temperature is usually between 850 and 900°F. These compare with pressures of 500 to 1000 p.s.i. and temperatures of 900-950°F commonly used in thermal cracking. In the operation of Fluid Flow catalytic cracking plants, temperatures, pressures, levels, and liquid and gas flows are automatically controlled by extensive instrumentation. These units frequently have about 200 automatic control devices and are excellent examples of the work of electrical and instrument engineers. The process is controlled from a room in which the instruments are arranged systematically on panels. Small deviations in normal plant temperatures, pressures, flows and levels are signaled to the operator by klaxons and different colored lights.

The design, construction and operation of catalytic cracking plants of widely varying capacity has required the careful application of engineering principles. Plants vary in size from those which crack as little as 1,500 barrels of oil a day to mammoth units processing 41,000 barrels of gas oil daily. In structural size, the larger plants exceed anything previously built in oil refineries. The cracking reactor of the 41,000 barrel plant is 35 feet in diameter and 41 feet high while the regenerator is 55 feet in diameter and 35 feet high. The catalyst transfer lines between the reactor and the regenerator are 9 feet in diameter. The plant contains a thousand tons of catalyst which is completely circulated every 20 minutes.

In the past decade, the charging capacity of catalytic cracking plants has increased from zero to over 1,600,000 barrels a day of gas oil. These plants produce about 700,000 barrels a day of gasoline. In 1940, catalytically cracked gasoline accounted for only 2 per cent of our total gasoline production. At present it accounts for 25 per cent and is increasing because of the need of modern high compression engines for high octane gasoline. The motor method rating of catalytically cracked gasoline is about 82 octane.

### Polymerization

As a by-product of cracking, gases are produced that contain olefins. For a long time these gases were burned under boilers and stills. Now they are

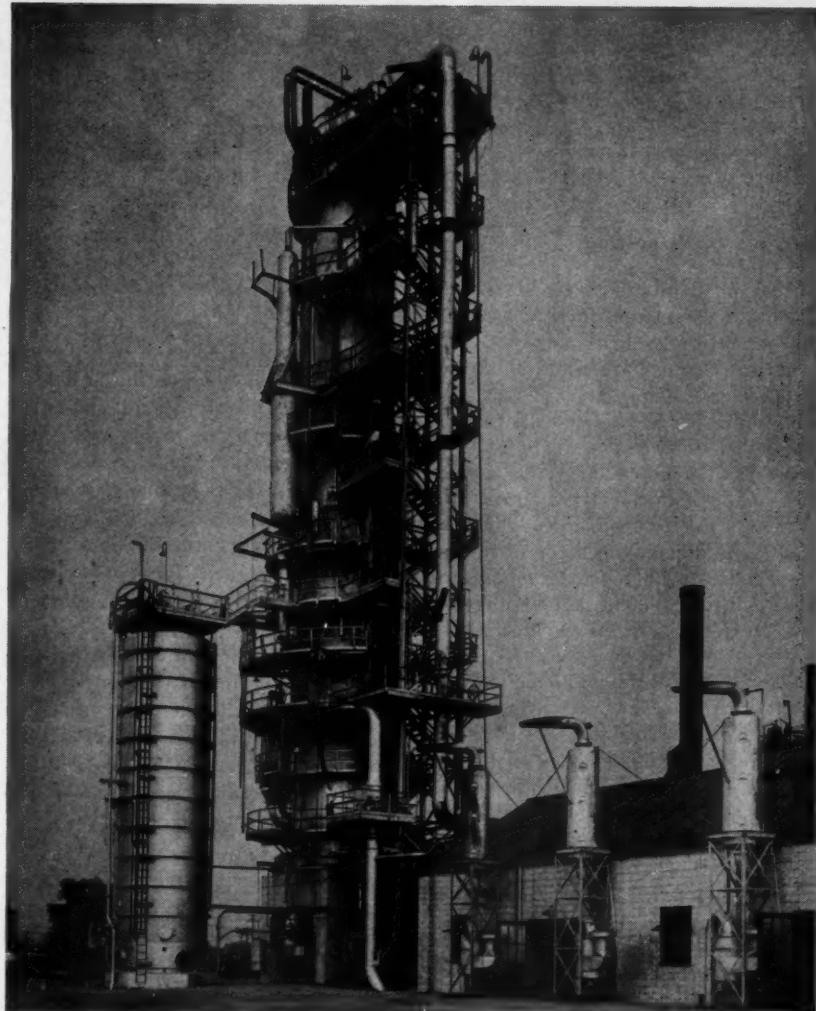
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**Figure VI.** Fluid Catalytic cracking plant of the Aurora Gasoline Company. Courtesy of Universal Oil Products Company.

processed to make gasoline by catalytically polymerizing the olefins. The charging stock for the polymerization units consists of a fraction containing propylene, butylenes, propane and butanes. This fraction is passed through reactors containing solid phosphoric acid catalyst, at temperatures between 300 and 450°F and at pressures between 500 and 1000 p.s.i. Because of the exothermic character of the polymerization reactions, some means for removal of reaction heat is required to maintain the proper temperature. In one method of operation when the olefin content of the gases is high and much heat is evolved the catalyst is contained in a multi-tubular reactor and a cooling fluid is circulated around the tubes to abstract heat. When water is used, the temperature is maintained by controlling the pressure under which steam is

generated. In another method, the catalyst is contained in multiple beds in a large chamber and temperature is controlled by the injection of liquid propane or butanes obtained as residual products from the process. These liquids cool by absorbing heat in their evaporation and by dilution of the olefin content of the gases.

#### Alkylation

An important process for the production of aviation gasoline is called paraffin alkylation. In this process, isobutane is reacted with gaseous olefins using such catalyst as aluminum chloride, sulfuric acid and hydrogen fluoride. The operation of processes using these corrosive catalysts has called for unusual engineering skill. Only within the last ten years has the corrosive and

violently reactive hydrogen fluoride been used on a tonnage basis. It was found that mild steel was sufficiently resistant to corrosion by anhydrous hydrogen fluoride and that it could be transported in steel cylinders, tank cars and even pipe lines. In catalyzing the alkylation of isobutane with propylene and butylenes, the hydrogen fluoride is vigorously agitated with the liquid hydrocarbons under pressure, the mixture is then settled, the acid layer recycled and the gasoline recovered by fractionation.

In hydrogen fluoride alkylation plants, the corrosive effects of the catalyst made necessary a search for special metals and packings in valves. Monel metal was the best valve material. Ordinary asbestos packing was useless because the hydrogen fluoride reacted with the silicates. Satisfactory packing was provided by selected plastics and either copper or silver wool. The new acid resistant plastic known as Teflon has been tried and found satisfactory. On the drive shafts of impellers in the reactors the shaft was flushed with a portion of the hydrocarbon mixture to be reacted. The recovery of hydrogen fluoride required a separate distillation unit. The defluorination of the alkylation products was eventually completed by filtration through a tower packed with aluminum rings. The reactors and settlers of one commercial hydrogen fluoride alkylation plant contain 350,000 pounds of liquid hydrogen fluoride. About 15,000 barrels a day of hydrocarbons are charged to this unit, which can produce as much as 8,200 barrels of alkylate. The octane rating of alkylates is between 90 and 95 by the motor method.

#### Lubricating Oils

The portions of petroleum from which lubricating oils are made, are the heavy distillates obtained by the vacuum distillation of residuums after heating oil and diesel fuel have been distilled from the crude. The majority of crude oils contain wax which occurs principally in the lubricating oil fractions. At present the principal refining processes in lubricating oil manufacture involve solvent extraction. High quality oils are made by eliminating asphalt, wax and oils of poor lubricating properties. Asphaltic and resinous impurities are selectively precipitated by dissolving the oil in liquid propane and heating to

(Continued on Page 22)

# The Engineer in the Oil Industry

(Continued from Page 21)

about 180°F under a pressure of 500 p.s.i. After removal of the asphalt, the oil-propane mixture is cooled to 30°F below zero to eliminate wax. Methyl ethyl ketone, a product from petroleum, is also used in dewaxing operations. The separation and purification of wax is a job for the refrigeration engineer, as it involves the use of refrigerating equipment in all methods. The wax separated by solvent methods is microcrystalline and has a high melting point in comparison with waxes separated by chilling and filter pressing. The microcrystalline waxes have melting points from 180 to 200°F, while the waxes recovered by other methods melt from about 115 to 135°F.

A variety of single and double solvents is employed for removing constituents having poor lubricating properties which consist generally of oils of aromatic character. These oils are lacking in viscosity and also in their resistance to loss of viscosity when heated. The oils left after asphalt, resins, wax and aromatics have been removed, have the properties most desired in satisfactory lubricants. Selected crude oils and proper choice of refining methods give oils for every service. Lubricants are available for the delicate mechanisms

of fine watches, for the cylinders and bearings of internal combustion engines, and for heavy industrial machinery. Lubricants are also produced which are used in gears under extreme pressures which sometimes reach 400,000 p.s.i.

## Engine Fuel Testing

The automotive engineer studies the relationships between fuels and engines by laboratory methods and road tests, and the characteristics of motor and aviation gasolines, tractor fuel and diesel fuels are accurately measured and compared. The engineer is engaged in increasing compression ratios and in determining what octane rating fuels will meet engine requirements. He has developed different methods of testing: the motor method corresponding to severe driving conditions on hills and open highways, and the research method corresponding to moderate speed driving in traffic. Automobile engine compression ratios now vary from 6.5 to 7.5 to 1. Successful road tests have been made of cars with engines of 12 to 1 compression ratios, which show mileage increases of 30 per cent over stock cars. This engine required gasoline having a research octane rating of 100.

The automotive engineer is also improving airplane engines and the gasoline which they need for efficient operation. Here also tests are made both in

the laboratory and in the air. The highly supercharged reciprocating engines of modern planes require fuels of over 100 octane rating. Such fuels cannot be compared on the present octane scale, which cannot be extended beyond 100, and a different scale has been worked out based on the power developed in airplane engines in comparison with 100 octane fuel. Readings on this scale are known as "performance ratings."

An enormous amount of research and development is going on in the field of jet propelled planes. The oil and motor industries are trying to lower the high fuel consumption of these planes, which runs as high as five times that of airplanes powered by reciprocating engines for a given distance. Some of the requirements in a jet fuel are low freezing point, high heating value, rapid burning rate and low carbon formation. For some time it seemed that kerosene met all requirements, but lately there has been a shift to the use of gasolines with octane ratings between 50 and 65, because of easier cold starting and better burning characteristics, lower viscosity, and greater availability.

The automotive engineer is also active in meeting increasing demands for high speed Diesel fuels. Demand is rising because of increased use of Diesel

(Continued on Page 30)

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## Furnaces for By-Product Fuels

(Continued from Page 9)

economical shipping distance, to replace more costly coal or oil.

### Hog Fuel

In the manufacture of lumber the amount of material removed from the log, to produce sound lumber, is approximately: 18 per cent in the form of slabs, edging and trimming; 10 per cent as bark; and 20 per cent as sawdust and shavings. While the total waste material will usually average around 50 per cent, distribution of different types of waste may vary widely from the approximation given above. The mills frequently use the sawdust, or a mixture of sawdust and shavings, for steam-production purposes because they can be burned without further processing. The remainder of these so-called waste products require size reduction in a hog to facilitate feeding, rapid combustion, transportation, and storage. These newly sized products, together with varying percentages of sawdust and shavings, constitute hog fuel. The moisture content of this fuel may vary from approximately 40 to 55 per cent. In addition it may range from salt-water hemlock to fresh-water fir. These factors of moisture, wood species, and whether fresh- or salt-water borne logs were used, are of considerable importance in providing adequate and suitable furnace designs.

Hog fuel is bulky and the basis for purchase and sale is volume rather than weight. The accepted standard is the unit, equivalent to 200 cu. ft. of hog fuel as measured in the containing vehicle of transportation, without packing. The weight of a unit will vary from 1700 lb. to 2300 lb. of dry wood, depending on the species, the moisture content, and the amount of shavings and sawdust present in the mixture.

The process of combustion with hog fuel, because of high moisture and volatile-matter content, consists in three consecutive and somewhat overlapping stages: preliminary drying or evaporation of the moisture; distillation and burning of the volatile matter; and burning of residual fixed carbon.

The design of a suitable furnace for hog fuel firing must take into consideration the manner in which the combustion process is carried on, and at the same time make due allowance for pos-

sible wide variation in wood species, size and moisture content.

A two-stage furnace, comprising a Dutch oven for the drying and gasification of the fuel, and a secondary furnace in which combustion of the gaseous products is completed, provides a relatively simple yet effective arrangement.

Hog fuel firing is a matter of surface combustion and the use of refractory arches and walls in the primary, or Dutch oven, furnace is therefore of considerable importance. Their function is to provide the maximum amount of radiant heat for maintaining gasification and prevent the fire from becoming extinguished, even though the overfeed principle of continually supplying fresh fuel to the surface of the incandescent cone shaped pile is used.

The arch location, with reference to the fuel pile, governs responsiveness to load variations. Its contour, with drop-nose at primary furnace outlet, provides a sloping surface from which the maximum amount of heat is radiated on to the fuel pile, and at the same time forms a shield against the cooling effect of the boiler heat-absorbing surfaces.

The fuel is supplied to the furnace through openings in the arch. It has been established that a grate 9 ft. square is close to the economical limit that can be adequately supplied with fuel from one feed opening. This factor together with the known slope of the pile and the desired clearance between arch and

apex of the fuel cone, makes it possible to determine the required height of arch above the grate. Individual Dutch ovens of this type are known as cells, and a steam generating unit is provided with as many cells, all discharging their products of combustion into a common secondary furnace, as may be needed to develop required capacity. These individual cells provide better control of combustion conditions and also permit periodic cleaning without shutting down the unit.

The amount of hog fuel which may be burned in a cell of the above type will vary from 1.5 to 3.0 units, depending on wood species, whether it originated from salt- or fresh-water logs, the size of the fuel, as well as the consist of the wood mixture. These data are based on forced-draft operation with air at room temperature. Operation can be maintained with 30 to 40 per cent excess air.

A number of installations have been made in which two or three feed openings in tandem are used to supply each cell. In these the fuel pile consists of a number of overlapping cones corresponding to the number of feed openings. Individual cells are usually about 8 ft. wide and up to 24 ft. long. With this arrangement it is possible to provide greater wood-burning capacity per ft. of furnace width, even though operation is not quite as satisfactory as with

(Continued on Page 24)

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## Furnaces for By-Product Fuels

(Continued from Page 23)

the smaller cells using only one feed opening.

A unit equipped with a tandem furnace, has been designed to burn redwood refuse having a moisture content of 50 to 55 per cent. Three cells, each having two fuel-feed openings for a grate 6 ft. 8 in. wide by 18 ft. long, are used. Capacity is 100,000 lb. Steam per hr. is at 250 p.s.i. and 735°F. Burners for auxiliary oil firing are installed in the watercooled secondary furnace, for use when no hog wood is available.

### Paper Mill By-Product Fuels

The fuels which constitute some of the by-products in the manufacture of pulp fall into two classifications: wood-room refuse in the form of wet bark, culled wood, sawdust, ground-wood screen tailings, and butt ends; and spent

alkaline liquors from the chemical processes of digestion.

#### Wet Wood Refuse

The most important wood-room refuse, and perhaps the most uncertain as to quantity, is wet bark. As received from the barking drums it may contain 80 per cent or more moisture. In this condition it is of no value as a fuel because its as-fired heating value is approximately 1750 Btu per lb., and for every pound of dry substance there are 4 lbs. of water which must be evaporated before any heat is available for steam production. If useful heat is to be realized some preliminary dewatering must be resorted to. Presses may be used to reduce economically the moisture content to about 65 per cent. The pressed bark can then be mixed with the other wood room refuse and burned without further preparation. However, hogging before burning makes possible more uniform feeding and also contributes to improvements in the combustion process.

External bark dryers offer a means for utilizing heat in the flue gas to effect some additional moisture removal following pressing.

The use of preheated air for combustion provides a means for securing additional drying effect in the fuel bed.

In the use of any type of drying equipment, the removal of moisture from the waste fuel represents a gain in heating value, and therefore a direct saving in the use of purchased fuel or power. Likewise, an air heater installation represents an additional reduction in purchased fuel requirements. Comparative evaluation can be made, by balancing the fuel saving against fixed charges and operating costs of the dryer and air heater respectively, to determine if the installation of one or both types of equipment can be economically justified.

In the design of furnaces for mixtures of wet bark and wood, an hourly disposal rate of 20 to 35 lb. of dry solids per sq. ft. of grate is possible with moisture content of 65 to 70 per cent, provided auxiliary fuel is burned. For a moisture content of 55 to 60 per cent, an hourly disposal rate of 35 to 50 lb. per sq. ft. of grate is possible without use of auxiliary fuel, and these rates may be increased somewhat through the use of preheated air or the development of improved furnace designs.

The most widely used furnaces for burning this wet wood refuse are of the flat-grate, Dutch oven type, with either single- or multiple-feed openings. Auxiliary grates, oil burners, or pulverized fuel firing are frequently used to provide additional heat for disposing of the wood waste, and to generate simultaneously, or during periods of low wood supply, such steam as may be required to meet demands on the unit.

A steam generating unit has been designed to burn a mixture of pressed bark, sawdust, shavings, and butt ends, and equipped for supplementary pulverized coal firing. The wood-burning furnace consists of a two-cell Dutch oven with drop-nose arch and flat grates each 5 ft. wide by 12 ft. long. The products of combustion are discharged from this primary furnace into an upper, water-cooled, secondary furnace in which pulverized coal may be burned, either simultaneously with the wood, or separately if no wood fuel is available. The wood refuse has an average moisture content of 60 per cent, and with this fuel continuous capacities of 55,000 lb. of steam per hr. and 15 minute peak



### THE WESTERN SOCIETY DINING ROOM

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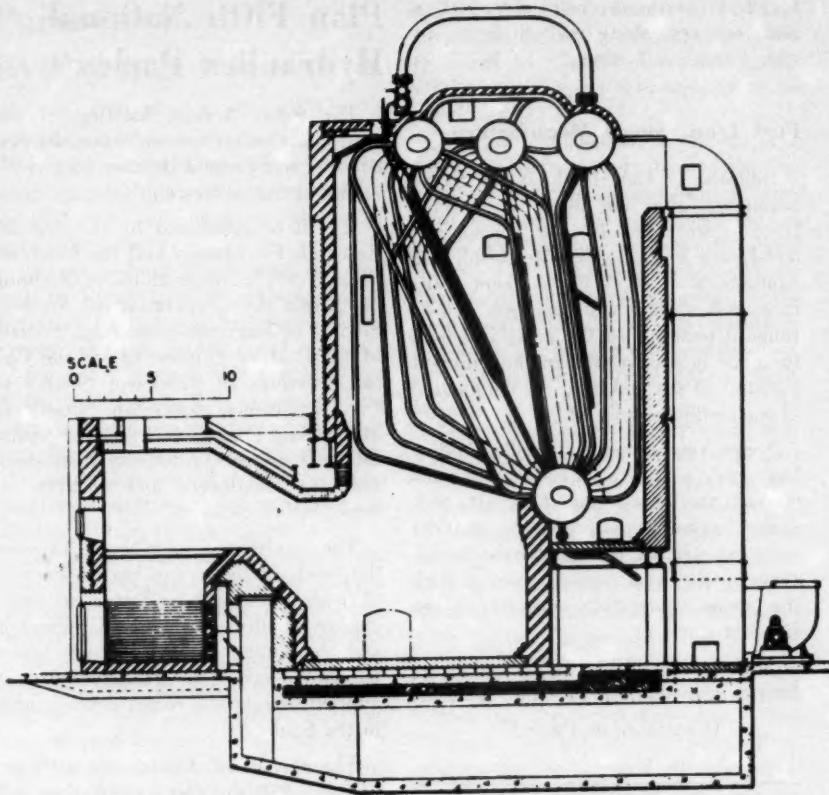
#### SELECTIVE MENU

(also Salads, Sandwiches)

Lunch  
11:30-2:00

Dinner  
5:30-8:00

*Buffet table has been discontinued*



**A C-E Steam Generating Unit equipped with horseshoe furnace for bagasse firing. Tubular air heater used with this installation. Courtesy, Combustion Engineering—Superheater, Inc.**

capacity of 85,000 lb. per hr. have been carried without difficulty. This unit has been free from slag deposits, even though coal and wood are frequently burned simultaneously. Complete water-cooling of the secondary furnace side and rear walls provide trouble-free operation and an almost total absence of maintenance charges.

In another type of furnace which is used by mixtures of wet bark and wood refuse, a sloping grate is used and the fuel enters the furnace at the front and over its full width. The fuel supporting surfaces are divided into three sections. The upper front section forms the preliminary drying zone, and consists of a refractory hearth having a slope of approximately 50 degrees. The mid-section consists of stationary grates set at a slope of 45 degrees and is provided with horizontal air-admitting opening. The grates of the lower section are set slightly less than 45 degrees and have fuel pushers which may be operated as required. Horizontal dump grates extend from the end of the grate to the bridgwall. Progressive feeding of the fuel from entrance to dump is secured

through the variation in grate slope. For large units these furnaces are sectionalized in the same manner as the flat-grate type. The Dutch oven uses a flat arch and the opening into the secondary furnace is screened by an arrangement of cooling tubes. In the lower portion of this opening the tubes are widespread while in the upper portion they are finned to present a barrier to gas flow and thereby cause it to sweep over the lower end of the fuel bed. Oil burners for supplementary firing, are located in the roof of the watercooled secondary furnace.

#### Spent Alkaline Liquors

When pulp for the papermaker is manufactured by the chemical processes of soda and sulphate, caustic soda is employed as the active chemical to separate the cellulose fiber, by dissolving the other wood substances. These dissolved wood substances are carbonaceous matter which is then burned in smelting furnaces to recover the chemical and use available excess heat to generate steam.

Alkaline pulp-mill operators call all chemical solutions liquors. Thus from their characteristic colors come the terms: black liquor, the solution after the diffuser and up to the recovery unit; green liquor, the solution in the dissolving tank; and white liquor, the causticized green liquor which forms the entire cooking liquid for the digesters.

The black liquor as it is washed from the pulp and discharged to the weak liquor tanks contains from 12 to 20 per cent dissolved solids. After passing through multiple effect evaporators its solids content is raised to 45 to 55 per cent. Additional evaporation is next carried out in the recovery unit, after which the liquor is mixed with salt cake and then pumped to the recovery furnace where remaining water is evaporated, the inorganic matter burned and the inorganic chemicals recovered.

The amount of dry solids per ton of pulp may be as low as 2000 lb. for kraft stock and as high as 3400 lb. for bleached sulphate. The calorific value of black liquor varies from 5200 Btu per lb. for soda liquors, up to 7000 Btu per lb. for rich kraft liquors. With this range in weight and heating value the approximate amount of steam produced will usually vary from 2400 to 3300 lb. per 1000 lb. of dry solids depending on design of unit and heat requirements for evaporation and chemical conversion.

The principal function of the recovery unit is to recover the chemical contained in the black liquor, and to reduce the salt cake to sodium sulphide. Carbon and organic matter are burned out of the black ash, and the resulting heat is used to smelt the chemical, and also to generate steam. The smelt runs continuously from the furnace over water-cooled smelt spouts into the main dissolving tank to form the green liquor.

The combustion process in units of this type is a critical low-temperature operation. The sodium salts in the liquor and smelt have a low temperature of vaporization and, as a result, some of these are carried out of the furnace, as a gas, with the products of combustion. The temperature of the gas is decreased in passing through the boiler and some of the soda is condensed and deposited on its relatively cold surface. The recovery of this soda is an important operation, as all of it must be returned to the hearth.

(Continued on Page 26)

## Furnaces for By-Product Fuels

(Continued from Page 25)

A completely integrated chemical recovery unit comprises furnace, boiler, superheater, soot blowers, evaporator, salt-cake feeding and mixing equipment, fans, air and gas duct systems, dissolving tanks, liquor pumps, controls and instruments.

The completely watercooled furnace, in the design illustrated, extends from the hearth to the upper small boiler drum. The hearth is of chrome refractory construction.

The lower portion of the furnace is divided into three overlapping zones between which there are no distinct lines of demarcation. Immediately above the hearth a reducing atmosphere is maintained to burn the organic residue out of the black ash, and to secure maximum conversion of chemical into smelt. The intermediate zone, is one in which a major portion of the moisture is evaporated from the black liquor as it emerges from the oscillating spray heads into the furnace. The heat for the evaporation process is obtained from the black liquor as it emerges from the oscillating spray heads into the furnace. The heat for the evaporation process is obtained from burning some of the organic compounds out of the sprayed liquor in the upper furnace zone, and also from completing the combustion of gas leaving the reducing zone.

Gas from the last boiler pass is discharged into a cascade evaporator where the densities of the black liquor are raised from 45 to 55 per cent solid up to 65 to 70 per cent solids for the furnace sprays.

### Recovery Main Object

Although one of the principal parts of a recovery unit is the boiler section, and its general appearance follows that of standard steam generating equipment, its distinctive junction places this heat-absorbing surface in a different category. The recovery of chemicals is the primary object, while resulting steam generating is of secondary importance. For this reason, the design shown is a carefully balanced combination of chemical process requirements and modern steam generating practice

to effect maximum chemical reduction and recovery, along with highest possible steam production.

### Fuel from Sugar Manufacture

Bagasse, or cane trash, is the refuse remaining after the juice is extracted from sugar cane. It is a fibrous material, similar in analysis to wood, and contains from 40 to 60 per cent moisture. Ash content will vary over a wide range depending on the areas in which the cane is grown and on the different amounts of silt picked up by the method of harvesting employed.

Steam requirements of mills producing raw sugar are easily supplied through the bagasse they turn out. Sufficient bagasse usually remains from the crop for starting the mill at the beginning of the next season, even though the steam generating unit is of the simplest sort.

Mills which operate white sugar refineries are required to supplement the

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## Plan Fifth National Hydraulics Parley

The Fifth Annual Meeting of the National Conference on Industrial Hydraulics will be held October 26 and 27, at the Sheraton Hotel in Chicago.

It will be sponsored by the Armour Research Foundation and the Graduate School of Illinois Institute of Technology, with the cooperation of Western Society of Engineers, American Society of Lubrication Engineers, and the Chicago sections of American Society of Civil Engineers, American Society of Mechanical Engineers, Society of Automotive Engineers, American Institute of Chemical Engineers and Institute of Aeronautical Sciences.

The conference is planned to meet the needs of those working in the field of hydraulics and to foster an interchange of ideas, methods of approach, and techniques, by presenting technical papers covering the fundamental and applied aspects and recent developments in the field.

The cost of all Conference activities will be \$18.50, and registration will open at 8:30 a.m. on October 26. Further information may be obtained from S. F. Musselman, Conference Secretary, NCIH, Armour Research Foundation, Technology Center, Chicago 16, Illinois.

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## Furnaces for By-Product Fuels

(Continued from Page 26)

bagasse supply with other fuels. In these instances the steam generating units may include economizers and/or air heaters so as to minimize the cost of purchased fuel.

Bagasse is burned somewhat like hog fuel in Dutch oven type furnaces on horseshoe-shaped hearths, or on inclined grates. The ash, which consists mostly of fine silt, is very fusible and produces a slag that is difficult to remove. These slag accumulations require periodic removal and because of this the cell type of construction is used so that the steam generating unit may be continued on the line during cleaning periods.

The most widely used furnace is the Cook, or horseshoe type. It consists essentially of a refractory Dutch oven, usually in the form of a horseshoe, provided with several rows of air-admitting tuyeres located around the curved portion of the wall. The horseshoe shape was adopted because of the ease with which it is possible to distribute the fuel over the entire hearth, from a single fuel feed opening in the arch, and also because of the absence of corners that are difficult to clean. The width of hearth may be varied from 4 ft. to 5 ft. 6 in., and the front to rear depth from

6 ft. to 7 ft. The number of horseshoe furnaces used for a given boiler is determined by the furnace width available, as well as on the capacity to be developed.

Air for combustion, supplied by a forced draft fan is admitted to the furnace through the tuyeres, which cause it to sweep over the surface of the fuel pile. The maximum rate at which bagasse can be burned on a hearth arrangement, as described above, is approximately 350 lb. of dry substance per sq. ft. per hr. and the most economical rate, however, is from 200 to 225 lb. per hr.

Some installations are equipped with auxiliary oil burners in the secondary combustion chamber. These may be used to assist in starting at the beginning of the season or to provide steam during periods when bagasse is not available. It is good operating practice to avoid burning auxiliary fuel simultaneously with bagasse, in the same unit.

Some sugar producing areas use the sloping grate in almost exclusive preference to the horseshoe type. This choice is dictated, in practically all instances, by the ash and silt content of the bagasse. Designs of this type are similar to those for wet wood and employ multiple cell construction.

### Conclusion

Present costs of standard fuels such as coal, oil and gas, have advanced to a high level and we must now revise some

## Present New Metal Punching Process

The Fox Valley Chapter of the American Society of Tool Engineers, will feature a technical lecture at its September 15 meeting by Robert E. Coleman, vice president of the Pivot Punch & Die Corporation. Subject of the illustrated lecture will be one of the latest methods of cost reduction in the metal stamping industry.

Bert Phillips, Chapter Chairman and president of the Phillips Auto Parts Manufacturing Company in Elgin, invites WSE members to attend this meeting, explaining, "The main function of the ASTE is to organize meetings where the latest methods of manufacturing can be presented."

The meeting will be held at the Baker Hotel in St. Charles, Ill.

of our concepts regarding so-called refuse fuels.

Today it is frequently economical to process some of the industrial by-products, which were formerly considered necessary waste, and use them to supplement and even replace standard fuels. How well the combustion engineer is meeting this challenge is shown by the many special furnace designs that have already been developed. Others are still in various experimental stages so that we can look forward to many improvements in methods for drying, feeding and burning by-product fuels.

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# WSE Applications

In accordance with the By-laws of the Western Society of Engineers, the following names of applicants are being submitted to the Admissions committee for examination as to their qualifications for admission to membership into the Society in the various grades, i.e., Student, Junior, Member, Associate, etc. All applicants must meet the highest standards of character and professionalism in order to qualify for admission, and each member of the Society should be alert to his responsibility to assist the Admissions committee in establishing that these standards are met. Any member of the Society, therefore, who has information relative to the qualifications or fitness of any of the applicants listed below, should inform the Secretary's office, 84 E. Randolph St., Randolph 6-1736.

## Applicants prior to June 1, 1949:

- 354-80 Henry M. Szypulski (Trsf.), Mech. Engr., Western Railroad Supply Co., 2428 S. Ashland Ave.  
355-80 Mark J. Hess, Asst. Chief Engr., Wilson & Co., Inc., 4100 S. Ashland Ave.  
356-80 William J. Meyer, Jr., Engr., Illinois Bell Telephone Co., 212 W. Washington St.  
365-80 Harold J. Connelly, 4531 N. St. Louis Ave., attending Illinois Institute of Technology.  
366-80 Charles F. Geiger, Senior Construction Engr., Ragnar Benson, Inc., 4744 W. Rice St.  
367-80 Robert Grove, Student Engr., Chicago Transit Authority, 79 W. Monroe St.

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- 359-80 Raoul du Chatellier (Trsf.), Tech. Writer-Communications Engr., Automatic Electric Co., 1033 W. Van Buren St.  
372-80 Roland B. Butterfield, General Plant Supervisor, Illinois Bell Telephone Co., 212 W. Washington St.  
373-80 Robert K. Mathews, Construction Engineer, Freyn Engineering Co., 109 N. Wabash Ave.  
375-80 Charles C. Veale (Rein.), Mechanical Engineer, Western Electric Co., Hawthorne Station.  
380-80 Kenneth J. Stanton (Rein.), Gas Development Engineer, Public Service Company of Northern Illinois, 1001 S. Taylor Ave., Oak Park, Ill.  
383-80 Henry S. Grzybacz, 2442 N. McVicker Ave., attending Illinois Institute of Technology.  
385-80 Fred B. Smith, Service Manager, Montgomery Elevator Co., 329 S. Wood St.  
386-80 Sumner S. Sommerfield (Trsf.), Consulting Engineer, 1913 E. Indiana, Wheaton, Ill.

## Applicants after June 1, 1949:

- 1-81 Edson E. Foster, Production Supervisor, Illinois Bell Telephone Co., 212 W. Washington St.  
2-81 Edward C. Gockman (Trsf.), 9333 S. Throop St.  
3-81 Robert E. Moore, Engineer, Illinois Bell Telephone Co., 208 W. Washington St.  
6-81 Donald M. McNamara, Science Editor, Scott, Foresman and Company, 433 E. Erie St.  
7-81 C. R. Strutz, Mechanical Engineer, The Oxweld Railroad Service Co., 230 N. Michigan Ave.  
8-81 Lawrence L. Weldy (Trsf.), Manufacturers Representative, (Owner), 4201 W. Irving Park Blvd.  
9-81 Diamond S. Dickey (Trsf.), Partner (Application & Service Engr.), Murphy & Dickey, 537 S. Dearborn St.  
10-81 Mitchell Zaretsky (Trsf.), Production Manager, Alba Art Studios, 1916 S. Trumbull Ave.  
12-81 Margaret S. Jones, Tool & Gage Designer, U. S. Navy (Civil Service), U. S. Naval Ord. Plant, Forest Park, Ill.  
13-81 James E. Dare, District Gas Supt., Public Service Company of Northern Illinois, Blue Island, Ill.  
14-81 Ervin B. Kodat, Mechanical Draftsman, H. P. Smith Paper Co., 5001 W. 66th St.  
15-81 Lawrence W. Johnson, Fire Protection & Safety Engr., Marsh & McLennan, Inc., 231 S. LaSalle St.  
16-81 Bob V. Cline, Engineering Draftsman, Pyle National Co., 1334 N. Kostner Ave.  
17-81 David J. Fischer, Owner, David Architectural Iron Works, 2019 Walnut St.  
18-81 Clyde E. Giller (Trsf.), Supervisor of Traffic Quarters, Illinois Bell Telephone Co., 208 W. Washington St.  
19-81 John C. Raaen, General Manager Research & Develop. Labs., Universal Oil Products Co., Drawer C, Riverside, Ill.  
20-81 Donald E. Ennis, Sales Engineer, Powers Regulator Company, 3821 N. Ashland Ave.  
21-81 Karl E. W. Hellsen (Trsf.), Supervising Engineer, United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia 5, Penn.  
22-81 Frank A. Miller, Manager, J. L. Simmons Company, Inc., 185 N. Wabash Ave.  
(Continued in the October issue)

## WSE Reviews Year

(Continued from Page 13)

deemed advisable, but, even so, many programs were not sufficiently advertised. It is hoped that this deficiency can be corrected next year. A considerable number of reports of committee chairmen emphasize the need for weekly notices."

### WSE Headquarters Fund

Turning to the subject of WSE's headquarters at 84 E. Randolph St., he stated, "Now a word about the status of the fund which is being used for payment of construction costs, furniture and equipment of our new headquarters. This is made up of voluntary contributions from the membership, from business and industry, and from others believing Chicago should have an engineering and science center. It is separate from our operating funds. Voluntary contributions to this Headquarters Fund have now grown to almost \$101,000 of which a little less than \$35,000 has been contributed by our membership and more than \$65,000 by business and industry. If our headquarters work had been started a year earlier, or if it could be started now, that amount would undoubtedly be sufficient. But all of you at all familiar with construction costs know that they were the highest of all time last year. So, notwithstanding the fact that all contractors and all furnishers of materials and equipment did their part without overhead or profit, the actual cost was \$107,700, at least 10% higher than reasonably could have been expected. We are in the position of having more than reached our objective of \$100,000 and still lacking \$6700 of having enough. At the present time all but two of the more than thirty contractors have been paid in full. These two have received partial payment and have signified their willingness to wait a little longer. It is a matter of regret to this administration that it becomes necessary to burden the incoming one with the task of raising even the relatively small amount still needed."

"Many of our members," he continued, "have assisted in the work of obtaining contributions from outside sources, but I think that all would agree that by far the greatest part of the credit should go to Herb Sedwick and Bill Kahler. I asked Mr. Sedwick to make the announcement tonight about the truly remarkable job done on the Head-

quarters Fund, but he asked to be excused because it is not completed. When it is, I hope he and Mr. Kahler are given the full credit they deserve."

"At about the middle of the year, it was the expectancy of our Treasurer, Donald Becker, that our operating income and expense would come close to balancing and that we might even increase our reserve fund by a small amount," Mr. McClurg said. "However, for the main reasons that the number of new members has been less than anticipated and that unavoidable delays in the completion of our headquarters resulted in loss of income from rentals and from operation of the dining room, he is now of the opinion that there will be an operating deficit for the year of about \$2000. We are perhaps that much worse off now than at the beginning of the year but probably will follow the precedent of many years standing, namely, using the first of next year's dues to pay off the remainder of this year's bills and leave the securities in our Reserve Fund intact."

Concerning other WSE activities, he stated, "There are many other things which could, and perhaps should, be said now about the activities of the Civic Committee under the chairmanship of L. E. Grinter, of the Junior Division with Bill Schlaix as chairman, of the newly formed and very active Women's Council, as well as those of other groups within the Society. But, I will leave them for the formal report."

"In conclusion, I wish to express my deep personal appreciation to our staff, to our officers, to committee members and to the many others in the Society who have worked so zealously in its behalf for the past year," Mr. McClurg said.

### Introduces New President

"Now there is just one more duty to perform and that is transfer of the responsibilities of the presidency of this Society to the man who will carry them for the next year," he said. "It is with the greatest of pleasure that I do this because I sincerely believe the Society will be in most capable hands. Dr. Egloff needs no introduction to this group or to any other engineering or scientific group in this country. Everyone knows he is generally recognized as one of the world's outstanding authorities on all matters pertaining to the petroleum industry. Dr. Egloff, I congratulate you on your election as President and turn

this meeting over to you," he said in conclusion.

Dr. Egloff responded, "The Western Society of Engineers has had a great year in bringing to fruition a new headquarters with exceptional facilities for its membership. This is a real start toward an engineering and science center. It offers a clubhouse, meeting place, and an auditorium of distinction. These facilities and many others that go with membership in the Society should offer a substantial inducement to prospective members. I know of no place in the Chicago area where one can obtain so much for so little."

"It was astonishing to learn that in 1930 the Society had a peak of 3200 members compared to a present membership of 2500," he said. "This surely does not parallel the 50 percent increase in American engineers from 226,000 in 1930 to 337,000 at the present time. Is it too much to ask that we strive in the coming year for a 50 percent increase over our 1930 registration, which would bring the total to 4800 members. With all that we have to offer today, there should not be too much difficulty in reaching this goal. All that is necessary is for each present member to bring in one new member. This sounds simple, and really, isn't it simple?"

### Committee Chairmen

"With the cooperation of every member we can look forward to a successful year," Dr. Egloff said. "Twelve good men and true have taken over the chairmanship of the twelve regular and special committees of the Society:

1. Finance, Donald N. Becker
2. Membership, Louis C. Gabbard
3. Admissions, C. H. Wicks
4. Program, L. E. Langdon
5. Publications, A. W. Howson
6. House, O. G. Smith
7. Library, J. E. King
8. Amendments, Verne O. McClurg
9. Awards, G. L. Jackson
10. Civics, L. E. Grinter
11. Development, E. Gordon Fox
12. Education, J. F. Farmer."

"Announcement will shortly be made of the chairmen of the Section Executive Committees and Functional Division Councils," he stated.

"May I ask you one and all to give a rising vote of thanks to Verne McClurg, our outgoing President who has done such a fine job in the past year . . . and please sit down for your incoming President," Dr. Egloff concluded.

# The Engineer in the Oil Industry

(Continued from Page 22)

engines in buses, trucks and locomotives. The railroads are rapidly changing from steam locomotives to Diesels because of far greater efficiency of Diesels. Over 90 per cent of present locomotive orders are for Diesels. At present our railroads use about 7.5 per cent of our crude oil production and 24 per cent of our coal. Estimates indicate that a complete conversion of the railroads to Diesel locomotives would require only 5 per cent of our petroleum and no coal. This would correspond to yearly savings of 50,000,000 barrels of oil and 150,000,000 tons of coal.

## Liquefied Petroleum Gas

A large amount of engineering has gone into the recovery, transportation and utilization of liquefied petroleum gases which consist principally of propane and butanes. These fractions are selectively recovered from natural and refinery gases, stored in large pressure tanks and marketed in bulk in tank cars, tank trucks, or in cylinders as bottled gas. The sales of this material increased three-fold from 1944 through 1948. Present production is at the rate of about 2,600,000,000 gallons a year. At present, 59 per cent of liquefied petroleum gases are used for household purposes, 11 per cent in industry, 11 per cent in city gas enrichment, and 19 per cent for chemical manufacture. Special high pressure equipment with pressure reducing and regulating valves has been designed for the use of these liquefied gases, and a high degree of safety has been attained.

## Carbon Black

The carbon black industry consumes approximately 10 per cent of our natural gas production, which was 5,600,000,000 cubic feet in 1948. The annual production of carbon black in the United States amounts to 1,400,000,000 pounds. In the older channel process, smothered combustion of natural gas deposits carbon on channel iron. In the later engineering development known as the furnace process, the smothered combustion is maintained in a large chamber and the suspended carbon black produced is filtered out in a

subsequent operation. Furnace black is reported to be better than channel black for use in tires, particularly those made of "cold" rubber. Carbon black has a number of important uses other than in tires, and inner tubes. It is an important ingredient of inks, paints, enamels, polishes, and phonograph records.

## Chemicals

At the present time, with increasing emphasis on the production of chemicals from petroleum, the engineer is being called upon more and more to design and operate special plants. A large percentage of chemical derivatives are made from natural gas and cracked gases.

The production of chemicals from the oxidation of natural gas is of growing commercial importance. Some of the products include methanol, ethanol, formaldehyde, acetaldehyde, acetone, and formic and acetic acids. The control of the oxidation reactions to produce major amounts of desired products calls for the application of both chemical principles and engineering. A recent development has involved the use of oxygen instead of air which in turn has made necessary the installation of plants for making oxygen from liquid air. One plant has a capacity of 2,000 tons a day of 95 per cent oxygen. This is the largest oxygen plant ever constructed. The production of 95 per cent oxygen corresponds to the greatest operating efficiency both in oxygen manufacture and its use in hydrocarbon oxidations. The use of oxygen instead of air reduces costs when operating under pressure.

Another recent development in the utilization of natural gas has been the recovery of carbon dioxide from California natural gases for the manufacture of dry ice. The carbon dioxide is extracted by a 20 per cent water solution of monoethanolamine. Over 2,300,000 cubic feet of carbon dioxide are extracted daily from 30,000,000 cubic feet of natural gas, and converted into marketable dry ice, with corresponding improvement of the quality of the gas as domestic fuel.

A series of alcohols is being made from petroleum in commercial quantities. Both ethyl alcohol and ethylene glycol (anti-freeze) are made from the ethylene in cracked gases. In the manufacture of ethyl alcohol, the ethylene is absorbed in sulfuric acid to make the

ethyl ester. From this, the alcohol is produced by hydrolysis. Seventy per cent of 160,000,000 gallons of ethyl alcohol produced in 1948 was synthesized from ethylene. Ethylene glycol is made commercially by two processes. In one the ethylene is catalytically oxidized by air to make ethylene oxide which is hydrolyzed to glycol. In the other process, ethylene is converted to its chlorhydrin by reaction with hypochlorous acid. This is converted to ethylene oxide by alkaline hydrolysis and the oxide is then converted to glycol by further hydrolysis. In 1949, 370,000,000 pounds of ethylene glycol was made from ethylene. Isopropyl alcohol is a unique petroleum product of which 75,000,000 gallons were produced in 1948.

One of the outstanding achievements of research and chemical engineering is the manufacture of glycerine from propylene. This hydrocarbon is first chlorinated at temperatures above 900°F to make allyl chloride. Further chlorination followed by alkaline hydrolysis yields a dilute solution of glycerine in water. Large multiple-effect evaporators bring about partial concentration of glycerine and the remaining water is removed by salting out. The glycerine is then distilled under vacuum for final purification. Special aluminum tank cars were built for shipping the product. The single commercial plant manufactures 35,000,000 pounds of glycerine a year.

## Synthetic Rubber

The petroleum engineer is in the forefront in synthetic rubber production. Synthetic rubber is no longer merely a substitute for natural rubber. Synthetic products are made for uses where the natural product is completely unsuitable. At the present time, U. S. consumption of natural rubber is at the rate of 600,000 tons a year and synthetic rubber is being used at the rate of 400,000 tons. Synthetics are available for every use and could supply total world needs if necessary. The oil industry can take complete credit for the development of Butyl rubber which has proven so exceptionally suitable for the manufacture of inner tubes. Butyl rubber is made by polymerizing isobutylene with about 2 per cent of isoprene at 140°F below zero. Inner tubes of this rubber retain air ten times longer than natural rubber and show markedly greater resistance to aging, wear, tear and abrasion. At present Butyl rubber

constitutes 60 per cent of inner tube rubber. The annual Butyl production is 60,000 tons.

Oil refineries produce butadiene by catalytic dehydrogenation of butylenes. Styrene is produced by the alkylation of benzene with ethylene, and dehydrogenation of the Ethyl benzene. These two products are bases for synthetic GR-S rubber. Research men have developed the process for making so-called "cold" rubber. The temperature of polymerization is 15°F compared to the 120°F

originally employed. The "cold" rubber tire gives 30 per cent greater mileage than those of natural rubber.

The present highly efficient operations of the petroleum industry are largely the result of applied engineering. During the past two years, the industry has spent \$4,233,180,000 for expansion in all its branches, and \$2,146,000,000 will be spent in 1949. In this enormous program the engineer will find many new opportunities for the application of his talents.

## Announce Fall Plans Of Technical Groups

The Fall Meeting of the American Society of Mechanical Engineers will be held September 27 to 30 at the Hotel Lawrence in Erie, Pennsylvania. Among the speakers will be F. A. Faville (M'47), President of Faville-LeVally Corp. of Chicago. Reservations should be sent to Mr. W. L. Hunter, Box 302, Erie, Pennsylvania.

The 13th annual National Time and Motion Study Clinic, sponsored by the Industrial Management Society, will be held in Chicago at the Sheraton Hotel on November 2, 3 and 4. Among the speakers will be James S. Knowlson, President, Stewart-Warner Corporation, Chicago.

The First Pacific Area National Meeting of the American Society for Testing Materials will be held in San Francisco, October 10 through 14.

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## OBITUARIES

Henry F. Dose (M'96), and a Life Member of Western Society of Engineers since 1927, died July 7 in St. Louis. He was located away from Chicago during the entire length of his membership.

William S. Shuma (M'48), died July 28 following an illness which had left him totally disabled. He was Chief Draftsman for Friedman, Alschuler & Sincere, and lived in Berwyn, Illinois.

William G. Evans (M'09), and a Life Member since 1940, died August 17. He was a resident of Chicago, Illinois, and had formerly been associated with the Chicago Park District.

Joseph H. Brown (A'19-'33; M'36), Sales Manager of the Barco Manufacturing Company in Chicago, died June 6. He was a Director and member of the Executive Committee of the Mechanical Engineering section from 1944 to 1947.

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(Continued from Page 29)

Newly-named Life Members who were not present at the dinner were: H. G. Armstrong, Alex D. Bailey, J. D. Barber, Horace M. Beebe, Byron Bird, Daniel J. Brumley, Hugues Brussel.

Albert B. Clark, Albert A. Colvin, Robert A. Cook, Harvey H. Cosley, Frank H. Cramer, Roy W. Emmert, E. H. Enander, Harry M. Engh, A. Epstein, August J. Fry, Samuel A. Greeley, Earle W. Grover.

Others were: George Havens, Walter L. Hempelmann, John Johnsen, Maro Johnson, T. A. Jordan, Wm. R. Jeffries, Paul B. Juhnke, Elmer H. Karp, P. W. King, Robert Knight, Geo. L. Lehle, R. C. Llewellyn, F. C. Loweth, Arthur T. Luce, Charles H. MacDowell, William W. Mathews.

F. A. Niemann, W. G. Nusz, Charles W. PenDell, Fred A. Poor, Chester L. Post, George A. Quinlan, Herbert S. Ripley, Maynard H. Riley, A. M. Rossman, E. O. Schweitzer, Homer I. Steffan, Emil A. Weber, Paul A. Westburg, Hugh E. Young.

Herbert S. Crocker (M'06) died in March, according to word just received from the family. He had been a Life Member since 1936, and was a resident of Denver, Colorado. He was a member of the Consulting Engineers Division.

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### Engineers Available

**DEVELOPMENT ENGINEER, M.E.**, 37 yrs.; having 5 years' practical shop training; 7 yrs. engineering design and development of production machinery and tools for small electrical devices; 5 yrs. ordnance automotive development as project engineer. Position desired: developing mechanical product or production equipment. Salary \$5,500. Midwest. #125-W.

**MECHANICAL ENGINEER**, grad., 25; 4½ yrs. research and development on machines and electro-mech. precision insts. Experience includes develop., design, testing, report writing. Also meth. and systems exper. and investigation. Interested in research, management or sales. #126-W.

**EXECUTIVE ELECT. MECH. ENGR.**, long experience directing design development and research projects; 12 yrs. chief engineer automotive accessories; 20 yrs. chief engr. scientific instrument field; 5 yrs. motored home appliances. Many U. S. patents. Prefer Chicago location. #127-W.

**CHIEF INDUSTRIAL ENGINEER, PRODUCTION or ASST. PLANT MANAGER**. Age 31; B.S., M.E. Ohio license. 10 years' supervision, production, and manufacturing processes; tooling, methods, plant layout, wage incentives, job eval. time study, cost control reduction and estimating, machining, fabrication, welding, punching, stamping, painting, assembly. #128-W.

**CHIEF ENGINEER, B.S. in C.E.** Age 37. More than 12 years' experience in pulp and paper industry, maintenance, construction crews. #129-W.

**AERONAUTICAL ENGINEER**, graduate aeronautical engineer, age 26. 1½ years' experience as stress analyst in guided missile research; 6 months' exp. in manufacturing trouble shooting, tool jig. and process correction. Interested in production. Location: Chicago. #130-W.

**ELECTRICAL ENGINEER**, graduate electrical engineer, age 26; 1½ years' experience all phases electric utility construction and industrial power distribution layout including Class II locations. 1 year journeyman electrician with contractor. Interested in power distribution or consulting engineer in Midwest. #131-W.

**CIVIL ENGINEER**, graduate, Illinois Institute, age 28; single; field and office engineer, county roads, railroad surveying-elevation, control, line and grade, computations. Structural drafting, track layout. Desires job as field engineer with established contractor. Preferably Middle West. #132-W.

**CONSTRUCTION & INDUSTRIAL MACHINERY SALES EXECUTIVE** seeking greater opportunity with increased responsibility, 15 years of successful sales accomplishment; excellent creative and merchandising ability based on sound ideas that penetrate and sell; capable administrator and organizer. Civil engineering background and experience. #133-W.

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**SALES ENGINEER-MANAGER**, graduate mechanical engineer, age 32; 14 years' experience machines, tools, and special mechanical equipment—building, estimating, designing, engineering and selling. \$7,000. Chicago headquarters. #135-W.

**STRUCTURAL DESIGNER or ASSISTANT PROFESSOR**, graduate civil engineer, Master Science, age 31; over 6 years' experience general structural problems, design, detail, and draft on structures, buildings, domes and industrial construction. \$4,800 up. Midwest, West or East. #136-W.

**ASSISTANT TO CHIEF ENGINEER**, graduate mechanical engineer; age 29. 2 years experience in large equipment steel plate fabrication for steel mills; supervising engineering (shop, field and sub-contractors) customer contact and estimating. 6 years' co-op in manufacturing of gas-electric industrial trucks, all departments to plant layout. Salary open. Midwest or West. #137-W.

**PRODUCTION ENGINEER**, graduate administrative engineer, age 35; 9 years' experience, electrical, electronic and electro-mechanical; production controls, tooling, methods, applications and sales contacts. \$5,500. Chicago. #138-W.

**PLANT ENGINEERING**, graduate mechanical engineer, age 35; 4 years' experience plant layout and extension, machine installation and set up; foundations, structures and weldments; process piping, equipment and machines, sheet metal departments, rubber, tin and printing. 3½ years' manager tool grinding. 3 years' apprentice. \$4,800. Chicago. #139-W.

**DESIGNER**, graduate civil engineer, age 26; 1 year structural theory; 3 years' experience on box sewers, subways and superhighways; reinforced concrete construction, flat slabs, columns, foundations, girders, caissons, retaining walls, computations involving indeterminate analysis, 2½ years' on ship construction; inspection and field supervision of structural and mechanical installations. \$4,800. Chicago. #140-W.

**PROJECT ENGINEER**, designer-layout; age 38; heating, ventilating and air conditioning; 11 years' mechanical engineering experience on industrial, office, commercial and processing installations; design, layout, draft, supervise file and drawing room, estimate, specify, install, co-ordinate trades, make field surveys and prepare reports (progress and mechanical requirements); complete heating, ventilation, refrigeration, air conditioning, exhaust, power and process piping systems. \$5,000. Chicago. #141-W.

**CONSTRUCTION SUPERINTENDENT—FIELD ENGINEER**, graduate civil engineer, age 28. Over 4 years' experience on industrial and commercial buildings; all phases of complete construction and alterations from original contract or requisition through material ordering, field inspection and supervision to completion. \$4,200. Married, 23 years old. Location: Chicago. #143-W.

**ARCHITECTURAL DRAFTSMAN**, woman, B.S. in Architectural Engineering. University of Illinois. Architect's license. Two years' experience in architect's office—working drawings and engineering on modern residential and commercial work. Married, 23 years old. Location: Chicago. #143-W.

**TIME and MOTION STUDY-METHODS ENGINEER**, graduate mechanical engineer, age 32; 9 years' experience on small electrical products, electro-mechanical machines and woodworking; factory estimates, rate setting, incentive systems, standards, inventory; all departments of mill, machine shop, assembly lines, fabrication departments. \$4,000. Chicago. #144-W.

**DEVELOPMENT-PRODUCTION ENGINEER**, graduate electrical engineer, age 24. One year experience on motor generators, wire and cable and electronics mathematics; development of variable speed generator and commutation, applications of wire and cable. \$3,600. Chicago. #145-W.

**DRAFTSMAN-DETAILER**, graduate mechanical engineer, (Tau-Sigma) age 29; 1½ years' experience boiler installations and heavy equipment; layout, calculate and draft structural and mechanical; list materials and figure efficiencies. \$3,000. Midwest, West and South. #146-W.

**FIELD INSPECTION ENGINEER**, graduate civil engineer, age 25. Over 1 year experience in insurance fire protection inspection of industrial plants; examine, inspect, evaluate and report on protection system, hazards and specific corrections. Desires job in construction as field engineer or on inspection. \$3,000. Any location. #147-W.

**SAFETY ENGINEER** (fire protection and safety engineering courses, chemical engineering, airline operator) age 31. Over 3 years' experience in electrical-mechanical manufacturing; safety, fire and accident prevention, building and equipment inspection; investigate fires and accidents, examine installations and eliminate hazards. Over 4 years' expediting aircraft parts from component parts to major assemblies, supervised 8 people. \$3,600. Midwest or West. #148-W.

**DESIGN MAINTENANCE TESTING ENGINEER**, graduate mechanical engineer, Purdue. Age 23. 1 year experience electrical-mechanical manufacturing, writing specifications for manufacture and installation of central office dial equipment. Desires position in manufacturing or processing of Diesels, machinery petroleum or pharmaceuticals. \$3,000. Chicago or Los Angeles. #149-W.

**PURCHASING AGENT-MATERIALS EXPEDITER**, age 39; over 7 years' experience on electrical and electronic equipment, purchase, expedite and co-ordinate all television studio equipment, materials and supplies; installed and maintained radio and radar equipment. \$3,600. Chicago and Indianapolis. #150-W.

**PURCHASING AGENT**, mechanical engineering training, age 37. 8½ years' experience of sprayers, agricultural equipment, refrigerators and temperature controls, use of chemical supplies and steel warehouses, purchased metals, mill supplies, maintenance equipment, maintained records and carried on general office work and sales correspondence. \$3,600. Chicago. #151-W.

**DESIGN-DEVELOP**, graduate electrical engineer; age 38; 13 years' experience engineering, designing, developing, and applying generators and control equipment; electrical motors. \$6,000. Midwest preferred. #152-W.

### Positions Available

*Include postage to cover forwarding and return of application. If placed in a position as a result of an Engineers Available or Position Available advertisement, applicants agree to pay the established placement fee. These rates are available on request and are sufficient to maintain an effective non-profit personnel service. Prepared ENGINEERS AVAILABLE advertisements limited to 35 words, with typed resume attached may be submitted to ESPS Chicago by members of Western Society of Engineers at no charge. A weekly bulletin of positions open is available to subscribers. Apply ESPS Chicago.*

R-5866 **ASSISTANT MECHANICAL SUPERINTENDENT** M.E. or E.E. degree; 28-35; 4-8 years' experience in industrial mechanical department. Completely experienced in large refrigeration units, steam plant; informed on electrical and construction work. Will lay out, check, supervise and inspect new installations of equipment and machinery. Must be good draftsman and detailer. Salary \$5,000-\$5,500. Location: Chicago.

R-5865 **ANALYTICAL CHEMIST** (for testing division) graduate chemical engineers, minimum 2 years' experience in laboratory work. Will make chemical tests of a wide range of products, supplies and equipment for a procurement agency. Salary \$315. Location: Chicago.

R-5863 **MECHANICAL DESIGNER**, graduate or equivalent, 5 years in design of tanks and conveyors, knowledge of mechanisms and structures; will design elevated tank installations and related equipment for a manufacturer. Salary open. Location: Chicago.

R-5862 **INSTRUCTOR**, recently graduated from some good metallurgical school with some training in physical metallurgy. Would like to develop applicant into a permanent teacher on staff. Salary \$3,000 for the academic year. Location: Midwest.

R-5861 **TIME STUDY AND METHODS ENGINEER**, 30's; 5 years' experience with factory methods or time study, knowledge of elemental standards and times study and methods work for industrial engineering firm. Salary \$80-\$100. Location: Chicago.

R-5857 **FIELD SERVICE ENGINEER**, electrical engineering training, young, some experience with electric rotary equipment (inverters, generators and motors). Will examine and adjust operating difficulties of installations on customer's premises for a manufacturer. Salary \$300-\$325 plus expenses. Travel to customer's plants required. Headquarters: Chicago.

R-5856 **DESIGNER**, graduate mechanical engr. 30-40 years; 4-5 years' experience mechanical design of heavy machinery or large tooling. Will design control mechanisms for printing presses, reels, rolls, etc. Salary \$400-\$500. Location: Chicago.

R-5852 (b) **SALES ENGINEER TRAINEE** C.E., Arch., or M.E. 23-28, single preferred for fabricator of structural steel, (joists, reinforcing steel, etc.), sold to building trade, construction engineers and users. Must have definite and tested aptitude for selling, better than average scholastic record. Training program includes indoctrination in shops, engineering dept. and Chicago field office. Salary \$250 to start.

R-5864 **METHODS ENGINEER**, substantial experience with improvement of labor utilization in connection with candy making or other related processes for a manufacturer. Salary range \$6,000. Location: Middle South.

R-5849 **DESIGNERS (heavy machinery)**, grad. M.E. or equiv. under 45; min. 5 years' actual design experience heavy equipment (gears and shafting) for crawler tractors, cranes, drag lines, shovels, winches and other hoisting machinery. Capable to assume responsibility and follow thru to completion. Salary approximately \$6,000. Location: No. Indiana.

R-5848 **STRESS ANALYST**, B.S. in Engng. 30-45; 5 years' experience with implement or engine builder on stress analysis, knowledge of farm implements use, stress analysis and design. Guide group of 3, work with plants of a farm implements company. Salary open. Location: Illinois.

R-5565 (a) **ASST. GEN. MGR.** grad. E.E. or M.E. 38-45; management experience in electrical and mechanical precision industrial machinery or equipment, modern organization and methods and over 500 employees; line executive position, administration, engineering and production manufacturing, product and planning (budgetary and modern management controls), background in precision production engineering and supervision. Salary \$10,000-\$12,000. (b) Sales Manager for above. (c) Sales Engineer for above.

R-5847 **PUMP DESIGNER**, Civil or Mech. Eng. graduate, 5 or more years' experience with centrifugal pump design; knowledge of hydraulics, completely informed about design of impellers for company manufacturing sewage treatment and water purification equipment. Salary open. Location: Chicago area.

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